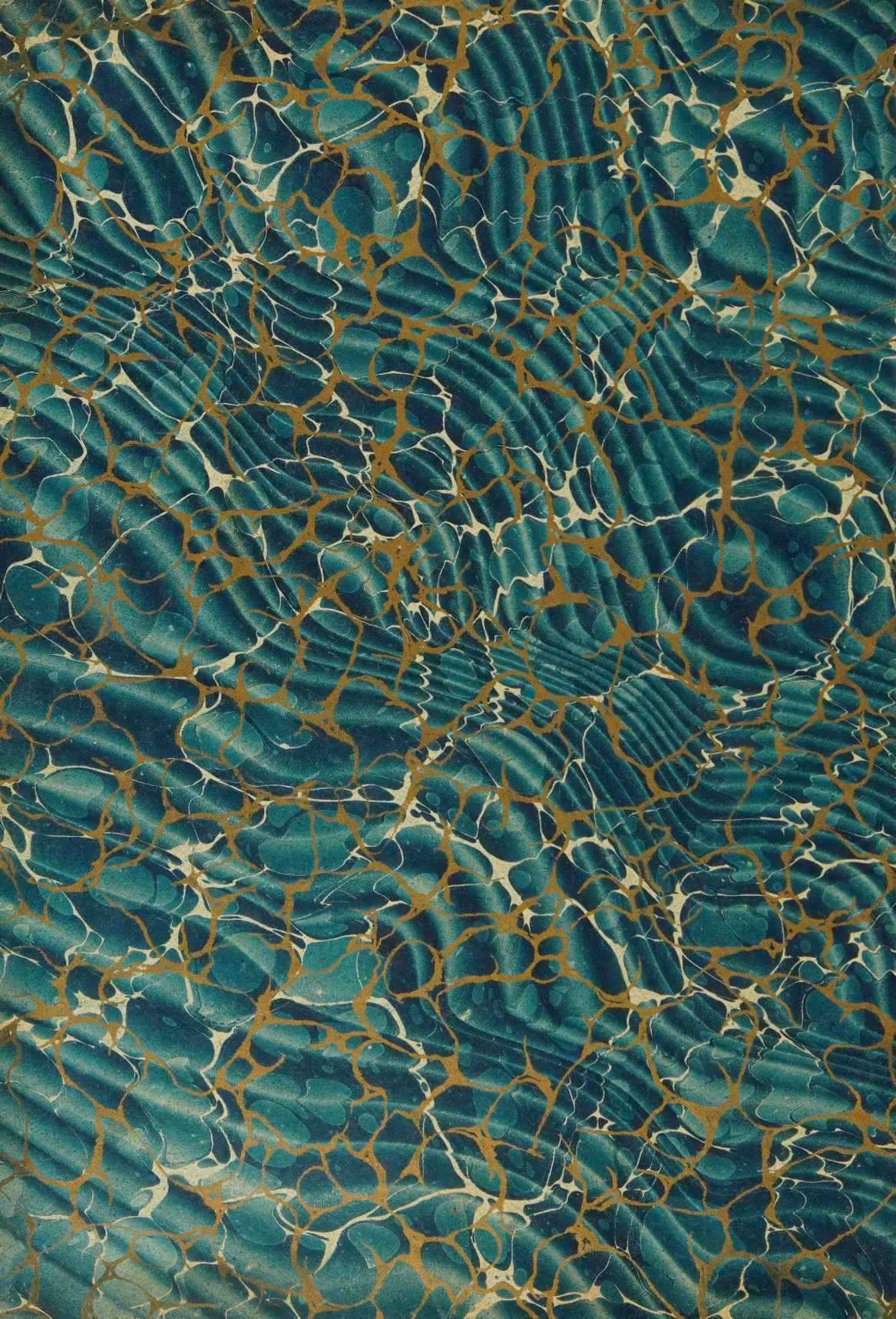
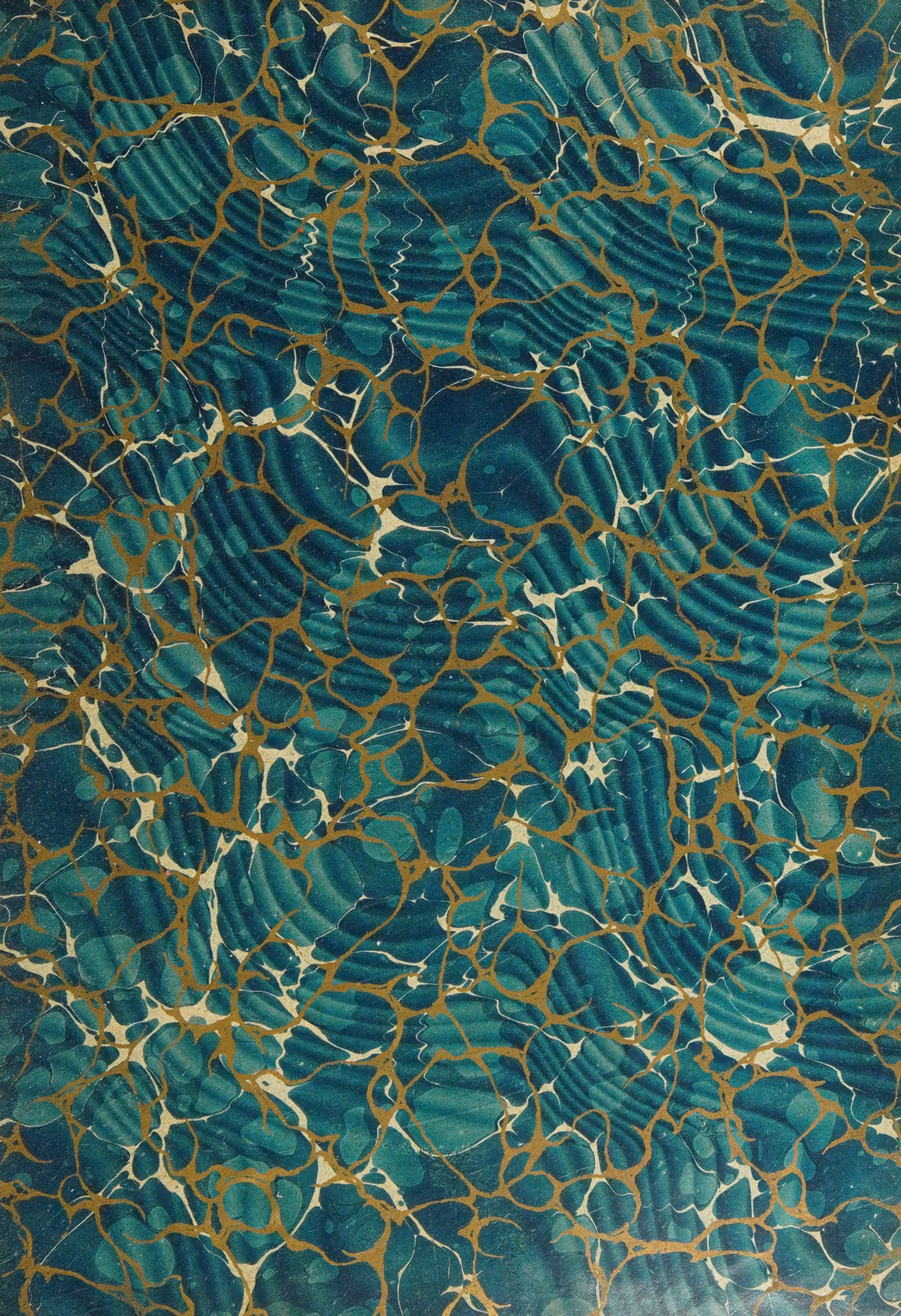










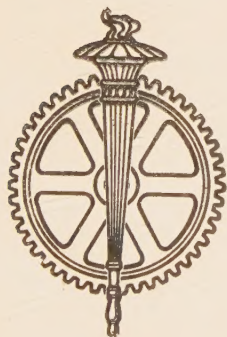
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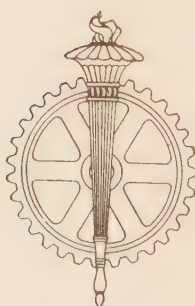
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No. 1

LABOUR UNREST IN THE UNITED KINGDOM

By John B. C. Kershaw, F. S. S.

Events occurring while these pages are actually being printed lend a deeper significance to Mr. Kershaw's searching examination of British industrial conditions, and emphasize the correctness of the vision of coming events which foresaw the immediate importance of such a study and dictated its commencement months ago. The analysis is not less significant to an American audience than to a British; present events in British industrial affairs point out rapidly forming tendencies in labor matters in the United States. Current British history is immediate American prophecy. Forces such as those liberated in the British general coal strike are perhaps beyond calculation. The effect of their operation can not be predicted, even from day to day. The greater importance, therefore, attaches to an analysis of fundamental causes which can be controlled; for proper control, applied nearer to the sources of influence, may avert a crisis which, whatever the outcome, can scarcely be less than a national catastrophe.—THE EDITORS.

THERE is a marked irony in the fact that directly after its triumph in August, 1911, over the House of Lords on the veto question, the British Government should have been called upon to deal with an industrial situation that recalled in many of its features the troubled days of the Chartist agitation in 1848-1850. Five years of Liberal-Labour Government and administration, had in fact, brought the country very close to the brink of industrial anarchy and revolution.

When one contrasts the social and industrial millennium which was expected to follow the three successive defeats of the Unionist party and policy at the elections of 1906 and 1910, with the position of affairs as

it exists today, the most ardent supporter of the present Government and administration must admit that there has been a wide discrepancy between election hopes and recorded achievements.

Had a Unionist Government been in power during the past six years, and had the present chaotic position been attained as the result of Unionist and Protectionist policy, one can imagine the recrimination which would have occurred, and the heated language that would have been used, by the more advanced members of the Liberal and Labour parties.

It is futile for Liberals to assert that the House of Lords had blocked industrial reform, and that the present unrest in the United Kingdom is

in any way the outcome of the constitutional agitation, or of the veto bill. As a matter of fact, all the more important bills and measures affecting the status or rewards of labour, introduced by the British Government during the last two Parliaments, have passed the House of Lords with only slight amendments, and have received the Royal assent.

The Mines Eight-Hour Act; the Trades Disputes Act, the Employers' Liability Amendment Act, the Old-Age Pensions Act, the act establishing labour exchanges, and a large number of similar measures, have all been framed and passed with the idea of conciliating the Labour party in the House of Commons and in the country, an increased annual expenditure of between £15,000,000 and £20,000,000 has been imposed upon the national exchequer by these measures, with little tangible result.

It is no exaggeration to state that the more important acts passed by the last two Parliaments in the supposed interests of labour, have failed completely either to produce contentment amongst the workers or to preserve industrial peace.

But although some political party capital can be made by this line of argument, the industrial position is too serious and grave to allow the subject to be dealt with merely in this way. All thinking men and women must recognise that the causes of the present labour upheaval and unrest in the United Kingdom deserve a fairer and more impartial examination than can be obtained under the light of party recrimination; and that attempts to fasten the whole of the responsibility for the present position upon the mistakes in policy or administration of the party now in power will only blind one to the real and deeper causes and meaning of the industrial and social crisis.

The South Wales coal mining troubles of the year 1910 were followed in 1911 by a host of lesser strikes culminating in the great transport, dock and railway strikes in the summer months of that year—and a semblance of peace in the world of industry has now been disturbed by the universal strike in the coal-mining industry.

It is foolish to assert that these strikes have been due solely to the activity of certain labour leaders, or to the indiscretions of two members of the present Government, and that they are not symptoms of a widespread unrest and dissatisfaction permeating numerous divisions of the ranks of labour. This discontent, in fact, has been slowly growing and accumulating during the past three years; and close students of industrial life in Great Britain have foreseen and foretold the upheaval which has occurred at last with such dramatic suddenness. That a small sectional strike of porters connected with one of the Lancashire and Yorkshire Railway goods' stations at Liverpool in August last should have spread until within ten days it had involved the majority of the transport and railway workers of Lancashire and the industrial North, was certainly a fact of the gravest import. The further fact that a general strike of the railway men of the United Kingdom should have been called for, with but hasty consideration by the men's recognised leaders, at the instigation of a demagogue who stood and still stands outside all the usual machinery of the Trades Unionist and Labour party movements, shows how completely the older methods of industrial struggle have been revolutionized, and how quickly, under the new conditions, the workers may be forced into action which is against their

truest interests, and detrimental to the welfare of the whole community.

Arbitration treaties and signed agreements between the representatives of capital and labour under these new conditions of industrial warfare have been treated as so much waste paper; and the older recognised leaders, who now form the Parliamentary Labour party, have proved themselves to be mere puppets in the hands of those who appear to control the new labour movement.

How feeble and ineffective this control is, was shown when Mr. Tom Mann attempted, last August, to induce the Liverpool dock labourers to return to work under the terms of an agreement with the shipowners, which he had himself signed on their behalf only a few weeks before. His attempt was a complete failure, and both Mr. Tillet and Mr. Mann have proved that it is far easier to create a strike than to settle it; and that settlements and agreements which they themselves consider satisfactory may be repudiated by the men whom they pretend to lead and control.

It is my purpose in this series of articles to analyse the various causes that have led up to the present most serious position of affairs; to discuss the significance of these causes in their relation to the social and industrial welfare of the community; and, finally, to indicate what in my opinion is the most hopeful method of avoiding strikes and of regulating the future relations between capital and labour.

The most important contributory cause has been *the increased cost of food and the rising standard of comfort and luxury demanded by the workers.*

Figures compiled by the British Board of Trade, and published in

recent Blue Books, prove that in London the cost of food consumed in a typical workingman's household has increased by 10 per cent since 1900, and by 20 per cent since 1893. In other words, 22 shillings will only go as far today, in food purchases, as 20 shillings ten years ago. There is no doubt that this rise in the price of foodstuffs has been general throughout the United Kingdom, and that in every working-class household a larger share of the weekly wages is now being devoted to the purchase and provision of food than was the case ten years ago. The corresponding figures for other European countries show still larger increases, and in France and Germany important parliamentary debates have occurred on this subject. And as to other domestic expenditures, no close observer of the British working classes can doubt that a large and increasing proportion of the income of all workers is being expended upon comforts, luxuries and amusements.

The extent to which the State is shouldering the responsibilities of the working man towards his family renders him far less inclined than in former days to practise thrift or to save money; and it is now customary, in most working-class households, to live up to or beyond the regular income, and to let the future take care of itself.

The cheap music halls, electric theatres and skating rinks, which have sprung up like mushrooms during the past ten years in all large centres of manufacturing industry, are supported chiefly by the younger members of the working classes; and the aggregate amount of money spent by them in these places is certainly large. The annual week's holiday and trip to the seaside, is also another new item of working-class

expenditure which has apparently come to stay, and is regarded as an essential by all workers in receipt of regular wages. The man earning 30 shillings or 40 shillings per week can meet these new items of expenditure without difficulty. The lower ranks of unskilled labour, however, have found themselves handicapped by these demands for increased expenditure upon food and luxuries, and the first and most potent cause of the frequent strikes in the labour world in recent years has undoubtedly been this desire to maintain, or improve, what is regarded as the standard of life and luxury common to their class. The fact that trade has been good and that the returns upon capital in the United Kingdom have been larger than for many years past, has, of course, simplified the problem; and during the years 1910-1911 the unskilled workers in many branches of British industry have claimed and received an advance in wages.

The ease and rapidity with which the workers in the shipping, dock and transport industries obtained an advance in wages, and the recognition of their various unions, during 1911, no doubt helped to precipitate the later difficulties and unrest in the railway world, and made these men somewhat impatient of the slow methods of inquiry imposed by their conciliation boards. The case of the railway workers is now settled, and it is not proposed to deal with it specifically here. In the light of the above facts there would appear to have been a strong case for the advance in wages which they claimed. It may be pointed out that the non-recognition of the men's unions was not directly the cause of the August agitation and strike, and that it was only after the strike became general that the question of recognition of

the men's unions was thrust into the first place by the union officials.

As regards the still more recent agitation amongst the miners for a minimum and standard wage in the different districts, this trouble has been brewing for some years, and has been aggravated by the Miners' Eight-Hour Act, which the Government passed in 1908.

The claim of the miners, if analysed, simply means that the wages of those men who are earning the lowest wages, whether as a result of incompetence or a bad working place, are to be levelled up to the general average, in order that they may be able to enjoy the same standard of life, both as regards necessities and luxuries.

Before these words appear in print the dispute may have been settled, probably on the basis of conceding the men's demands under certain specified conditions to prevent slack work, and some other branch of labour will be making a similar demand, backed by similar threats to dislocate the whole trade and industry of the country, if the demand is not at once complied with by their employers. The contagiousness of the unrest is, in fact, one of the most serious features, and what is occurring in the United Kingdom today, is only symptomatic of what may be expected in other countries in 1913 and later years.

A second contributory cause of the present labour difficulties and troubles is *the disproportionate growth of the casual labour and hooligan element in all city populations.*

The British census returns of 1911, when fully analysed, will reveal some striking information in connection with this subject, for the more efficient and self-reliant surplus of the population is emigrating, while the dregs remain behind.

During the past ten years (1901-1910), according to the Board of Trade figures, 2,841,000 persons of English, Scotch and Irish origin have left Great Britain as emigrants, an average of 284,000 per year. The numbers who emigrate are also increasing rapidly, the average for the five years (1906-1910) being 334,179 per annum, as compared with 234,168 for the period 1901-1905. In 1910, 398,119 persons emigrated from the United Kingdom, and this number will be exceeded, it is highly probable, by the total for the past year.

As regards the inefficient who remain, it must be remembered that no man describes himself as a "casual" or dock labourer who has been trained to any trade or handicraft, although he may have earned nothing at the latter for years. The statistics of this particular branch of unskilled labour are therefore untrustworthy; and one can rely only upon observation made in seaport towns for confirmation of the truth of the statement that the "casual" is *increasing more rapidly in numbers than any other class of the industrial army*. The ranks of the casual labourer are also being continually recruited by numbers of youths who are turned out into the industrial world from blind-alley occupations and industries at a critical stage in their life's history, and grow up to form the irresponsible and dangerous hooligan element in our populations. These two classes together represent a far larger proportion of town and city populations than is yet fully grasped, and are an ever increasing danger to the stability of society and of the State. They live in a chronic state of under-employment, lack of food, and of the ordinary decencies or comforts of life. Having little to lose, and in the majority of cases no wives or families

dependent upon them, these men and youths are ready on the slightest pretext to join in street rioting and looting, and there is little doubt that the disgraceful scenes of intimidation and bloodshed that accompanied the strikes of 1911 in the United Kingdom, were started and fomented in many cases by this most dangerous element of the population. The *sabotage* which characterised recent strikes in France is another example of their methods of conducting industrial warfare. The menace to life and property which results from the existence of this class is more fully recognised, now that there has been such a startling example of the reckless behaviour and savagery of these men.

The distrust produced in the minds of capitalists and manufacturers by the tendency of recent British legislation, and the consequent flow of new capital into other channels than those of British industry, must be named as another important contributory cause of the present industrial unrest. This distrust has intensified unemployment, and has added indirectly to the ranks of the casual and unskilled labourer.

Those who travel much in the industrial districts of the North, will know how little relative expansion is occurring, and how rare it is to see the walls of a new factory or chimney rising above the ground. *British industries, in fact, except in those cases in which special influences are at work, are not growing at the same rate as the population.*

During the ten years (1891-1900), the registrar of new joint-stock companies in the United Kingdom reported a capitalisation of £2,023,000,000, or an average of £202,000,000 per year.

During the past decade (1901-1910), the corresponding figures

were £1,372,000,000, or £137,000,000 per year, a diminution of over 30 per cent. This falling-off would have been larger still, had not the company promotions due to the "rubber boom" inflated the figures for the year 1910.

British capitalists, in fact, have become dissatisfied with the returns or with the security offered by industrial investments at home, and, seeing the tendency of recent legislation, have preferred to invest their money in foreign stocks or bonds, or in new commercial and industrial undertakings outside of the United Kingdom.

The emigration returns quoted above tell the same tale of non-expanding home industries, and of the diversion of British capital into foreign or colonial industries. As already stated, the result of this is that the best portion of the surplus population emigrates, or follows the capital abroad, while the casual, the loafer, and the hooligan remains to complicate and intensify the labour troubles at home.

Three causes of the unsatisfactory industrial position are now to be dealt with that may be grouped together, for they are political in character and relate to the *policy and administrative methods of the present British Government*. There is a disposition in some quarters to attempt to lay the whole responsibility for the creation of the present difficulties upon the shoulders of the Liberal party and Government. In my opinion this is unfair, since it ignores not only the more important question of the rise in the cost and standard of living that has already been dealt with; but also other contributory causes which have yet to be named.

But, while maintaining that it is unfair to attempt to impose the

whole of the blame upon the Government, there is no doubt that they are partly responsible for the position of affairs which exists in the United Kingdom today. Their legislation of the past four years has tended to weaken and to undermine the character and self-reliance of the workingman; while their failure to maintain law and order during the South Wales miners' strike in 1910, and their direct encouragement of appeals to class-hatred, and of attacks upon the impartiality of magistrates and judges, have helped undoubtedly to bring about the orgy of violence and strife which has been recently witnessed.

As regards the first of these charges, the working man is relying more and more upon the State for the discharge of duties and responsibilities that it were better and wiser he himself should bear. The responsibility of the State for the education of his children, and for the maintenance of himself and his family in case of sickness or accident, is now extended into the domain of work; and the labour exchanges set up by the Government in 1909 are but another step towards the socialist's ideal of State workshops and of a "Right-to-work" bill.

The apparent ease with which the present Chancellor of the Exchequer has already extracted £15,000,000 per annum more from the pockets of the British tax-payer, for old-age pensions and other similar measures, and the light-heartedness with which he has undertaken to raise an equal amount for the financing of his further schemes of social reform, has undoubtedly affected the judgment of the working classes, and has rendered them *less thrifty, less inclined for hard work, and more ready to accept the leadership of any irresponsible mob-orator who cares to*

promise them an eight-hour day, and £2 a week, for life. At a critical period in the industrial and social development of the United Kingdom, when all the forces of the State and Crown ought to have been found on the side of fair-mindedness and authority, two Ministers of cabinet rank did not scruple to appeal to the lowest instincts of the common people; to sow distrust between the rich and the poor, and to promote discord and hatred in all ranks of society.

When the history of the British labour upheaval of 1911 is finally written, by some impartial historian from the safe distance of years, the influence of the speeches and actions of the present Chancellor of the Exchequer, and of the present First Lord of the Admiralty (Mr. David Lloyd-George and Mr. Winston Churchill), in the years that immediately preceded the outbreak, will certainly not be left out of the account. The best comment upon their past is provided by the surprise and indignation with which their vigorous speeches and action in defence of law and order, in August, 1911, were received by the Labour party within and without the House of Commons.

The two final causes that will be dealt with, relate to *the substitution of "syndicalism" or a "general strike" for the older and more cautious methods of trades-union warfare; and to the lack of discipline and self-restraint repeatedly shown by the younger generation of workmen.*

The following quotation from an article contributed by Mr. Tom Mann to the *Daily Mail* of August 17, 1911, makes clear the origin of the new movement, and the distinction between "syndicalism" and the older methods of the trades unionism of the past.

With the workers' movement, trade unionism served a good purpose while the employing class were sectionalised; but since, for whatever reason, the organisation of the master class became a fact that rendered it proportionally difficult for the ordinary trade unions of sectional character to achieve any good purpose, many, some dozen years ago, came to the conclusion that trade-union methods had so lamentably failed that other means must be found, and so they resorted chiefly to Parliamentary action.

In the opinion of large numbers, Parliamentary action has not proved effective, and instead of discarding organisation in the workshop the movement we are identified with recognises that no social or industrial change for the better can take place, except in proportion as industrial organisation becomes a fact, with the elimination of sectional trade unionism.

The older movement relied chiefly upon finance, and there could be no struggle unless there was a big war-chest. The modern movement does not depend upon money; it depends entirely upon agreement among the men and the exhibition of what we term the spirit and practice of solidarity. More can be done in one week on the basis of solidarity extended over a wide enough area, than can be done in a whole year with unlimited money in the absence of this solidarity.

Mr. Ben Tillett and Mr. Tom Mann, the apostles of the new movement in the United Kingdom, are both skilled mob-orators, and occupy positions of detachment from, if not of open hostility to, the official Labour party. They are also silent concerning the past history of "syndicalism," and do not inform their hearers and followers that neither in France, Australia nor America has it achieved any permanent success.

One of the most curious and amazing features of the attempted general strike of British railway workers in August, 1911, was the indifference of the regular and official labour leaders of the men to the trouble which was brewing, until the demands for a general strike became too loud to be longer ignored. The haste with which they and the Parliamentary Labour party then endorsed the policy that Mr. Tom Mann

had thrust upon them, called out all the men in defiance of the agreement with the companies which was still in force, and vied eagerly with one another in making violent speeches inside and outside the House of Commons, in order to prove their sympathy with the agitation and support of a strike which seven days earlier they would have condemned as foolish and unwise, has certainly proved an object lesson in the weakness of modern trades unionism, and has shown the futility of trusting to the so-called "leaders" to guide or control the men.

As pointed out by the Parliamentary correspondent of the *Times* in the issue of August 16, 1911, the most powerful weapon in the armoury of the "syndicalists" is the concerted general strike at a given signal, a weapon which if ever used with complete success, must mean the absolute paralysis of commerce and industry and entail untold suffering and misery upon thousands of people. Australia, France and America have all had some experience of the syndicalists' method of conducting strikes, and have defeated the attempts of the agitators who preached it.

As regards the effects of the lack of restraint and discipline among the younger workingmen, there is, in the United Kingdom, evidence of this on every side. The repeated failure of the English strikers to obey the orders and commands of their own elected leaders; their contempt for agreements and arrangements signed on their behalf by those whom they had appointed to represent them, and finally their direct encouragement of, and participation in, attacks upon the life and property of those who opposed them—these are proof of the growth of a wild and lawless spirit among the working classes. Under this malign influence the

"peaceful picketing" permitted by the British Government's "Trades Disputes" Act of 1906, has developed into the grossest form of intimidation and violence. During the strikes of 1911, the liberty and right of any individual to work if he wished has been practically non-existent.

In Liverpool and other large towns of the North, mounted military escorts were required to protect the carters and others who dared to continue their ordinary occupations, and it was estimated that fully one-half of the men participating in the strike would have returned to work, if they had been assured of adequate protection for themselves and their families. Had the strikers desired to repress violence and lawlessness, they could at least have suppressed the outrages committed by the hooligan element of the population; and could have supported the police in the maintenance of law and order.

As a matter of fact, the majority of the younger generation of workmen in the United Kingdom have become the dupes of the more advanced labour leaders, who deny the claims of religion, of duty or of authority, and preach the dawning of a new social era in which liberty and license shall reign supreme.

The teachings of this form of socialism have obtained a much deeper hold upon a large section of British labouring population than is yet generally recognised. There are discernible, in the lack of self-restraint exhibited by the strikers and their sympathizers during the labour troubles of 1911, the first fruits of this spirit of contempt for all forms of government or authority; and it is probable that before a change for the better occurs, further manifestations of this spirit of anarchy, accompanied by serious disorders, will be observed.

MINING AND CONCENTRATING THE SYDVAR- ANGER IRON ORES

By Dwight E. Woodbridge

The methods described by Mr. Woodbridge are interesting not only to the miner and metallurgist, but to the mechanical and electrical engineer. And to the economist, most suggestive facts and conclusions are presented in the general comparative unit-cost figures of iron production from the world's greatest fields. The equality is curious and striking; and its examination may prove of special significance at a time when important changes of economic legislation affecting the steel industry are pending in the United States.—THE EDITORS.

A METALLURGICAL operation in which many million dollars are invested for the purpose of grinding hard rock to dust and extracting therefrom a product worth a quarter of a cent a pound is well worth notice, even in these days of exceeding refinement of the beneficial treatment of minerals. When one adds the further statement that this business is carried on in the far north where trees do not grow nor crops mature, subject to all the disadvantages of an arctic winter and the inconveniences of a three-months night, and that it is thousands of miles from any place where the product is worth that quarter cent, the daring character of the undertaking may be surmised.

This affair is at Sydvaranger, in Norwegian Lapland, which is 250 miles north of the polar circle and 200 miles east of the North cape. It was financed by a group of gentlemen associated with the Jernexport of Sweden, and by a leading Hamburg bank that advanced 12,000,000 kronor for the enterprise. The advance was made after thorough and careful examination of the mines, and after tests had shown the ore to be beneficial by the Grondal magnetic process. This examination disclosed masses of iron mineral covering an immense area and of a probable quantity of about 450,000,000 tons, lying

above the level of the sea. As the deposits are apparently of a magmatic nature, that is, as the mineral is disseminated throughout an original eruptive rock, it is probable that the deposits are somewhat connected and are of great depth, and no estimate can be made of the total tonnage that may, some time, prove available.

A commission to investigate iron ores and their mining and reduction in certain parts of northern Europe, found me on a bleak November day, aboard the trim little steel ship *As-trea*, a poststeamer of the Bergenske Dampskibsselskab. That morning, in cold and fog and rain, we had wound our way down Vefsenfjord below bleak and barren cliffs from Mosjoen to the sea. Four days later, after such fierce buffeting by the arctic seas that most of the passengers left the ship before we reached our northing, I arrived at Sydvaranger, on the Russ-Norwegian frontier in Lapland. It is the jumping-off place, and the little Russian settlement just across the river is that country's furthest-most outpost in northwestern Europe.

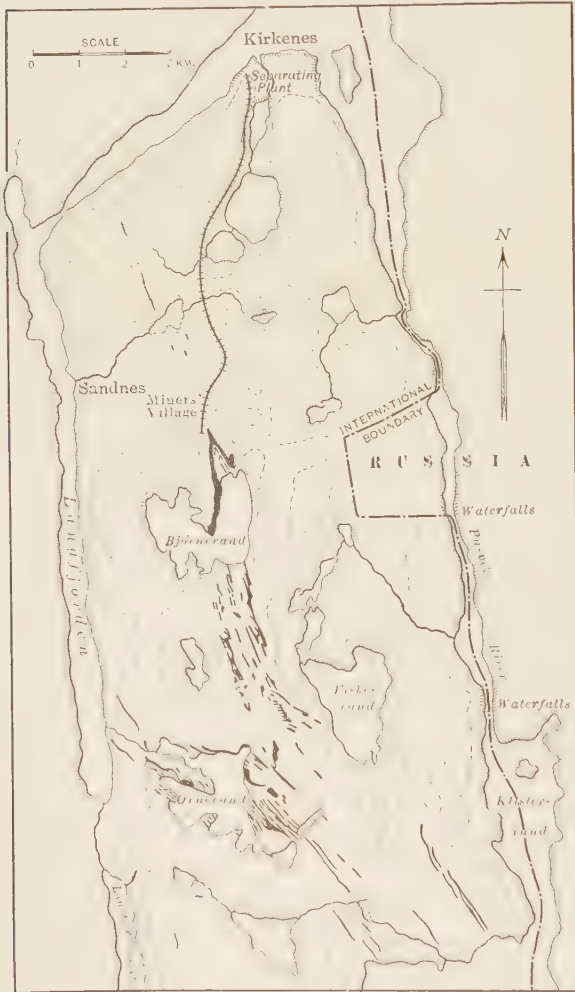
The journey up the coast was a most interesting one. The ship coasted the frowning and glacier-planed rocks of what is, literally, an iron-bound land, for the rocks of the Norwegian mountains for a distance of more than 500 miles north and east from latitude 66 contain a consider-

able proportion of iron mineral; it is true that in most places this is too lean to be now available for commercial use, but its totals are staggering to the imagination. With abundant water power at hand, and with water

than fifty-million cod are annually taken; and, at Svolvær, we met hundreds of vessels of the fishing fleets. These seas off the Lofoten islands swarm with cod, and Baedeker says that at times and places hereabouts a line thrown into 50 fathoms of water will not reach bottom for the backs of the fish.

It is the sea that supports northern Norway; without its harvest life would be impossible, and the government so fully realizes this fact that it has established complete telegraph and telephone communication between the Lofotens and the mainland, and upon many of the outlying islands has wireless stations for communication between the fleets and the shore. Svolvær is a town of two or three thousand fisher folk, but it has its water mains, its electric lights, its sewers, its cables and its well stocked shops. We passed Narvik, the most northerly railway terminus in the world, and threaded the island passages to Hammerfest. All night the ship unwound the tortuous line of the channels, and in the morning there was nothing in sight but the hurtling arctic seas and, far abaft, North cape holding its great wall against them. At every port was the over-
overpowering stench of fish guano and rancid cod oil.

At Vadsø the next morning I changed to the lokalsteamer Varanger, and spent the day crossing the great fjord of that name. Strong east winds were blowing from the White sea and the tiny steamer of 110 tons tossed in a most uncomfortable and disquieting manner. The cabin was a mite of a hole well aft,



The Engineering Magazine

MAP OF THE SYDVARANGER IRON REGION

transport to all the markets of the globe, who will have the hardihood to say that sometime these deposits may not be made use of? We passed the mouths of fjords cut deep into the interior; glaciers, brilliant in the sun, stretching their widths across the distance. We saw the Norwegian cod-fishing industry, by which no less



THE CONCENTRATOR BUILDING

and crowded by women and babies; the deck was unprotected, and the wind was bitterly cold and raw. How well I remember that I spent the day alternately freezing in the lee of the pilot house and thawing under the shelter of the smokestack! And there had been no opportunity for a meal between a supper on the *Astrea* the night before and another that evening, when I sat down in the chilly dining room of the hotel at Kirchenes—which is Sydvaranger.

Lapps are the grubstake prospectors of the far north land. Some nine or ten years ago, searching for copper, they ran across the iron exposures of the region lying south of Varanger fjord and west of the Pasvig river. These came into the hands of Mr. C. Anker, from whom they were secured by the present owners. The entire field consists of ancient

crystalline rocks, of an age much similar to that of some of the ore-bearing regions of Lake Superior. These rocks are chiefly gneiss with quartzite and schists, traversed by outbursts and dykes of greenstone. The strike of the stratified rocks approaches north and south and the dip of the formation is usually at flat angles to the east. But the entire rock series has undergone tremendous compression, folding and contortion, and there are many changes in the strike and dip. The ore deposits are developed in the stratified rocks within zones of alteration caused by the greenstone intrusions; and the ore consists practically of a gneissic rock containing quartz, feldspar, hornblende and epidote, with magnetic iron. It is fortunate that there is practically no iron of the hematite variety, thus making pos-

sible the separation of the economic mineral from the valueless, with little loss. In this respect these deposits differ decidedly from that other vast iron-ore body of Norway, Dunderland, where the presence of a considerable percentage of hematite has ruined the opportunity for magnetic separation by usual processes.



EXAMPLE OF FOLDING OF LAYERS OF MAGNETITE
AND QUARTZ
Drawn to scale.

These Kirchenes deposits lie parallel with the stratification, their form approximates the lenticular, and many of them occur as contacts between greenstone and gneiss or quartzite. The tremendous folding that has taken place is as evident in hand specimens as in massive outcrops, and it is unusual to pick up a piece of ore that is not contorted and twisted in its stratification. Occasionally the ore has been concentrated to a richness up to 50 per cent, but in general it is not far from 35 per cent iron, and the proposition is essentially one for the beneficiation of the material. The deposits vary in width from thin seams up to 600

feet, and some may be traced continuously for a length of more than 6,000 feet. Prior to the erection of concentrating works some of them were drilled and it was found that they extended to sea level with no apparent change in nature. How much deeper they may go is unknown. To sea level there has been measured a tonnage of about 445,000,000 tons.

A theory of this iron-deposit formation has been advanced by a geological official of the Norwegian government as follows:

"They have been formed by the compression of the gabbro rock, which, together with other kinds of rocks, chiefly gray gneiss, is found on ridges that one can follow for kilometers. Mr. Anker's claims refer to an aggregate length of 40 kilometers along the ridges. Where the compression has been less accentuated, or where the gabbro has been less ferruginous, as a rule only hornblende or quartz have been formed. The value of the lode, therefore, varies considerably. The ore is found partly in small pressure zones within the gabbro, but mostly in large masses where the iron in the gabbro has often been separated out into iron ore by pressure, for long distances. In some places it appears as though the quartz had been entirely isolated, by pressure, so that it is found lying up against the iron ore strata as thick bands of quartzite."

Sydvaranger is a well-built town of several thousand inhabitants. Its dwellings are of timber imported from Arkangel or southern Norway, for no trees grow in that latitude. Its streets are graded, water, electric light, sewerage, etc., are all furnished without charge; there are good schools supported by the company, which provides fuel and many other necessities of life at cost, or

a trifling profit. The people are contented and comfortable. Three years ago it was without population; a few nomadic Lapps herded their half-wild reindeer upon the low, moss-covered hills. To-day, the comforts of civilization. Three years ago a bare rock shelving steeply into the black water; to-day, piers and loading arrangements that have cost \$2,000,000. Three years ago no means of transportation; to-day, a standard-gauge railway equipped with modern steel ore cars and fireless locomotives. Then, no smoke among these hills; now, a steam turbine plant of 9,000 horse power, with Babcock & Wilcox boilers, with all the automatic refinements of a high-class works. Then, a dream of concentration, but now the largest magnetic-ore treatment works in the world, erected at a cost of several millions.

These ore deposits cover a superficial area of about 1,100,000 square meters, which is double that of Dunderrland; they are from four to sixteen kilometers from the harbor. This latter is admirable; its water has great depth close to shore, it is completely landlocked, and is ice-bound for a very few weeks during the year.

Given the enormous tonnages of ore that these fields surely possess, their favorable situation for a short rail haul to the sea, the schistose nature of the rock, which permits cheap crushing, and the magnetic character of the ore, allowing complete magnetic separation, it was only necessary—funds having been assured—that some method of enrichment be adopted that would be simple, effective and cheap. This was easier said than arranged for, and it was some time before tests



AMERICAN STEAM SHOVEL LOADING ORE FROM QUARRY



CARS OF ORE EN ROUTE TO FIRST CRUSHING

made on this ore at works in Sweden and elsewhere had shown the satisfactory system. That of Dr. Grondal, a well-known metallurgist of Stockholm, was found to fit the ores, and was installed. Most of the concentration tests were carried out at the works at Lulea, on the Gulf of Bothnia. Here crude ore that had been brought down in pieces of about 300 millimeter size (say up to a foot in diameter) was crushed to the size of an egg and then fed to a Grondal ball mill, after which it was found that the complete separation of the ore and gangue materials begins only when the material has been reduced to a size of less than 0.2 millimeter. It was necessary, therefore that the ball-mill product be quite fine, and that a still closer crushing be carried out for the greater part of the material. For this purpose tube mills were in-

stalled for the purpose of regrinding the sands from the ball mills. Experiments with these mills showed that more than 99 per cent of the material was of finer comminution than 0.2 millimeter, that the iron concentrate was of about 68 per cent iron, and that there was a loss in the processes of concentration of about 9 per cent, which has since been considerably reduced. Typical analyses of crude ore and concentrates were as follows:

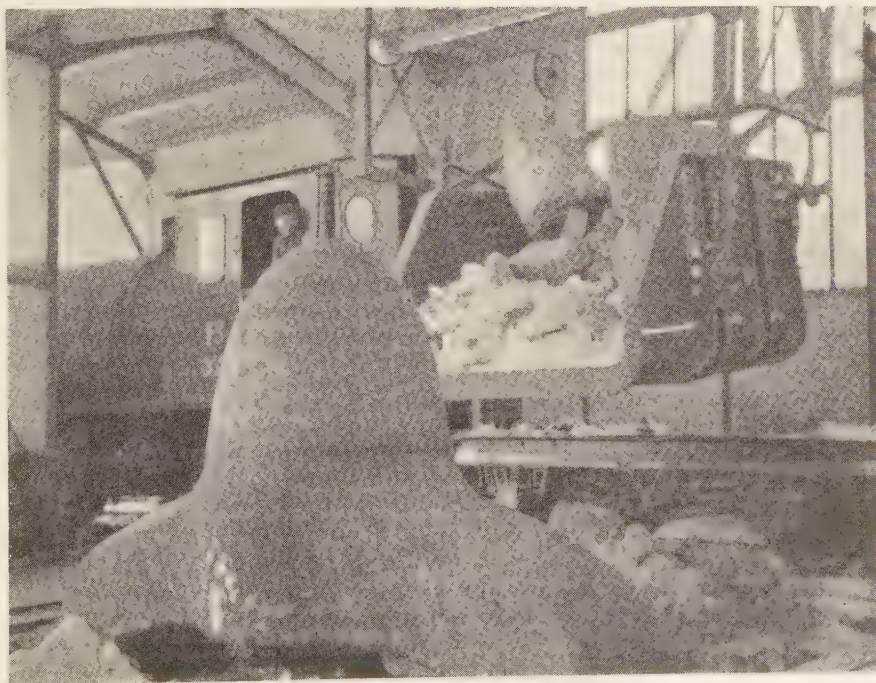
	Iron	Phosphorus per ct.	Sulphur per ct.
Crude ores..	34.5%	0.035%	0.065
Concentrates	68.4	0.006	0.015

Other tests showed results as follows: Percentage of iron in the crude ore, 36.6; percentage of magnetic concentrates, 50; percentage of iron in concentrates, 66.37, or reckoned as crude ore, 33.19; percentage

of iron in tailings, 5.12, or reckoned as crude ore, 3.06; percentage of total iron recovered, 90.7. In these latter tests the composition of the concentrates was: Iron 66.37, silica 7.85, phosphorus .016, and sulphur and titanitic acid, traces. These were all very satisfactory to the owners and the installation of a great mill on the basis of the tests was undertaken.

This mill has now been running, and quite successfully, I understand, for some time. It is based on a flow of ore beginning at the head of the mill where coarsely crushed ore from the mines is dumped into bins. Drawn from these crude-ore bins, the ore is put through jaw crushers of an English type, the Hadfield machine, which reduces ore to a size of 1.5 to 2 inches. This machine differs from the usual American types in

that the upper half of the moving jaw makes a flatter angle with the solid jaw than does the lower half, and the fulcrum of the movement is raised so high that ore pieces are strongly gripped and forced downward. Dropped from these machines, ore is delivered to an inclined conveyor belt that carries it to the head of a set of ball mills. This is the only point in the operation of concentration where the movement of ore is against gravity. Grondal ball mills are placed at the head of the main building, and into these ore is scraped by a fixed knife placed over a revolving disc. The grinding here is to 20 mesh. Each mill is fitted with separate motor drive and has a capacity for about 150 tons of material per 24 hours. Without other preparation the ore passes under Grondal magnetic separators, arranged in pairs,



THE BIG CRUSHER

all material going to each machine. By this means the feed can be very heavy, the upper machine overloaded, and particles of gangue material carried with the rush of ore and water onto the first are taken out by the second. These two mills give a concentrate running from 50 per cent to 55 per cent iron.

ing out of the second set of separators the final product assays nowadays about 69 per cent iron, 0.0015 sulphur, and 0.006 phosphorus. As pure magnetic iron ore is of about 72 per cent, Fe, it will be seen that there is room in these final concentrates for very little waste material.

The Grondal separator is a wet type



TUBE MILLS FOR FINE GRINDING

But as the tests showed that complete separation of the materials did not take place at any comminution coarser than about 200 mesh, and as the two ball machines are not designed for anything so close as that, the tube mills are placed beneath for second treatment. Therefore all magnetic concentrate from the two separators above is carried along at once, with its flow of water, into tube mills, where it is ground to powder, and then it goes to a second pair of separators arranged like the first and in every respect similar to them. Com-

machine, and thus the annoyance, losses and dangers due to dust in dry concentration mills are eliminated. The great experiment at Dunderland, that is said to have cost, all told, about \$17,000,000, was founded on a dry method. But Dunderland's failure is another story and was due to many causes, of which the manner of concentration was probably by no means the sole important one. The machines at Sydvaranger are drums having 43-inch face and 28-inch diameter and are arranged parallel, in pairs. These drums rotate around a system of fixed

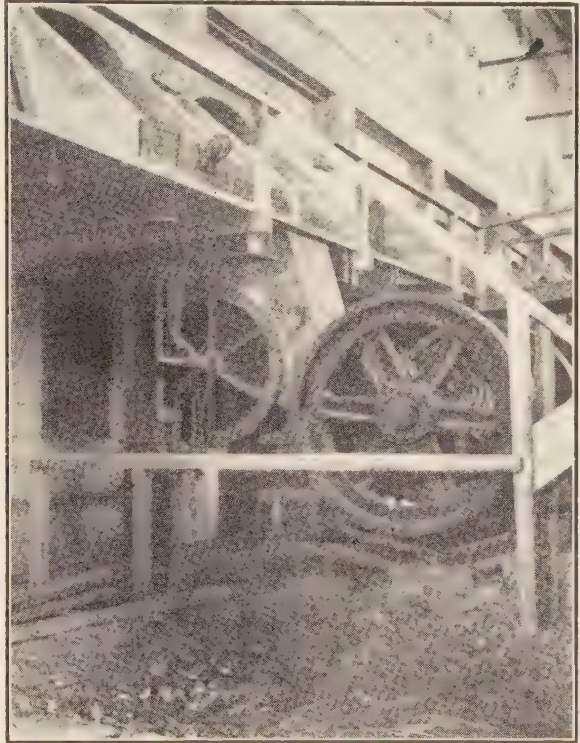
magnets, the whole placed just over a weir through which ore is flushed from the mills. Intense attraction developed from the magnets pulls out all magnetic particles from the flushed material, affixes them to the surface of the revolving drums, from which they are taken off by washing when the revolution of the drum takes them out of the field of attraction. Each pair of separators is driven by its individual motor.

After passing the final separators ore is delivered into settling tanks where much of the water is drained off. When it is dry it is taken by an automatic grab bucket and part goes to the briquetting machines, to be pressed for the nodulizing kilns, the rest into dry concentrate bins for shipment to destination. Whether or not this material is briquetted here or elsewhere it must be compressed or coagulated before introduction into the furnace, on account of its excessive fineness, and this process tends to demagnetize the product. It also reduces the proportion of iron in the mass by from 1 to 1.5 per cent. Briquetting done at these works is by the agency of producer gas, on cars run through a gas-flame furnace, whose waste heat warms the entire great structure. Coal consumption for briquetting is about 120 pounds fuel per ton of briquets.

It is but 1,200 feet from the concentrator building to the harbor front, where ships may lie and load direct for all ocean ports. Product of the mill and briquetting works is carried to the pier on an electric railway, third-rail system. It reaches the harbor at an elevation of 85 feet above mean water level, and is loaded into

ships by two German-built machines, Brown hoist style, that travel along the dock.

These have a combined capacity for loading 200 tons per hour. There is a depth of 26 feet of water at the front of the pier.



CRUSHERS IN THE CONCENTRATING MILL

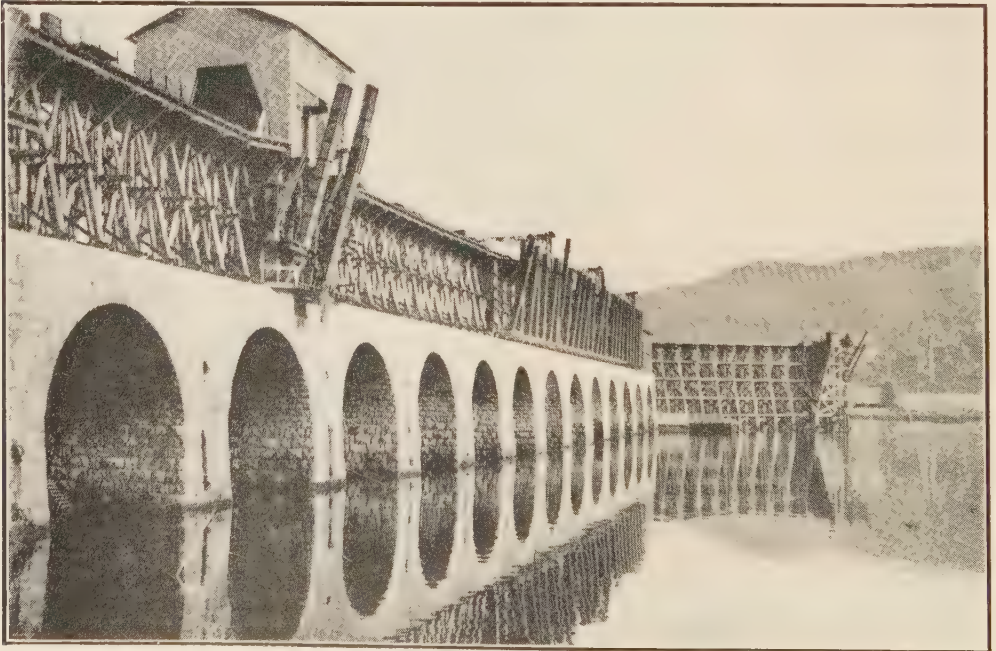
Some eight kilometers from the harbor and still less from the mines are falls of the Pasvik river, which stream is the boundary between Russia and Norway. These falls have a power more than sufficient to operate all the expected installations, and it was originally intended that everything should be run electrically, especially as the works are situated many thousand miles from the nearest cheap mineral fuels. But Russia had pushed herself across the river at the falls into Norwegian territory, and had taken possession of a tract several kilometers square on the Nor-

wegian side. On account of this ownership of the river at the strategic point it was found impossible to utilize the water power and the entire installation is for steam. Fuel is not expensive, a comparatively poor grade of Welsh coals, costing, delivered at Kirchenes, but 10 shillings the ton.

The main power station is intended to house three units of 3,750 horsepower each, and two of these have been installed. Each unit consists of Babcock & Wilcox steam generators, with mechanical stokers, superheaters and economizers, one DeLaval steam turbine for a three-phase alternating-current machine of from 800 to 850 volts, and up to 3,750 effective horse power, besides generators and pumps, and auxiliaries for other minor purposes. Five boilers are installed, and they deliver steam to the turbines at 180-pounds pres-

brick-filled, on concrete foundations, with everything resting on solid rock. The works are at so great a distance from any source of supplies and repairs that ample shops have been provided for any required duty.

The contract for power plant was made with the DeLaval Steam Turbine Company at Stockholm, and it was provided that there should be a coal consumption of not over 2.2 pounds per kilowatt hour, with both the 2,100-kilowatt turbines loaded and working condensing with superheated steam. This meant net coal consumption, including all auxiliary machinery. Tests that were made after the plant was in running order did actually show a coal consumption of 1.93 pound per kilowatt hour, with 35,000 pounds steam per hour for each turbine, or 16-pound steam per kilowatt hour.



ORE-LOADING PIERS, NARVIK

sure; two of these, with economizers, are in each unit, and one is a spare. As is the case with other buildings, the power house is of steel, walls

In order to utilize the cheaper imported coals the company has installed fireless locomotives on the short line between mines and mill.

These locomotives are charged with steam at 200-pound pressure from a stationary Babcock & Wilcox plant, situated near the mines. The advantage of this installation is said to lie in the fact that lower-grade coals can be used in the efficient stationary

per unit, and Spain is the great outside source from which the iron masters of England now draw their low-phosphorus ores. Cuban no-phosphorus ores might be delivered in Great Britain for considerably less money, and are splendidly adapted



A FIRELESS LOCOMOTIVE

plant than would be suitable for locomotive firing.

The final test of any enterprise is its financial success. While unable to state for just how much these ores can be mined, concentrated, and shipped to ports of ultimate use in Germany, Belgium or Great Britain, I think it is safe to say that the cost will be from 6.5 to 7 cents per unit of iron, when freights are at, say 6 shillings the ton. If freights are as high as 10 shillings, which may occur for a longer or shorter period, the price will be not far from 1.5 cents a unit more. The cost of Spanish bessemer ores in Britain is now about 10 cents

for use there in making high-grade steels, but Great Britain owns none of the enormous Cuban iron fields and no longer has the former opportunity to secure them at a most trifling cost. Lake Superior bessemers costs from 10 to 11 cents per unit on the Atlantic seaboard, according to the variation of the price on Lake Erie. It has been estimated that England could be supplied with the wonderfully high-grade ores of the Minas Geraes province, Brazil, at a net cost not to exceed 7 cents a unit.

It is a surprising fact that 6 or 7 cents a unit seems about the minimum cost for iron ore when delivered



SYDVARANGER CONCENTRATION MILL UNDER CONSTRUCTION

from many of the world's greatest fields at the several most advantageous points of reduction. This equality of cost is most striking, when it is considered in connection with the wide variations in character and purity of these ores, and with the great distances some of them must traverse to reach their markets. The 35 per cent ores of Sydvaranger, the 68 per cent magnetites of Kiruna, the 50 per cent chrome ores of Greece, the 36 per cent serpentine limonites of Cuba, the 68 per cent iron mountains of Brazil, can all be assembled at points of manufacture within an exceedingly narrow range of costs—so near alike, indeed, that so far as mere cost per unit is concerned, no great advantage lies with either one. The same is true for the 50 to 60 per cent hematites of Minnesota at new and near points of assemblage.

To be sure, the principal task for those who exploit a new mining region and a new product is to find the market. Doubtless some Sydvaran-

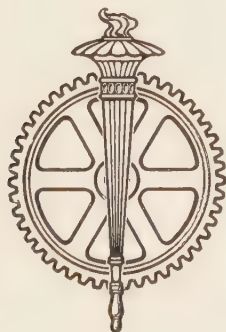
ger ore will be shipped to the United States, indeed some has been, but the chief field is on the Continent. There is no great difficulty in producing a Sydvaranger concentrate free from sulphur and phosphorus; the ore contains almost none of the latter, and what little of the former there may be is readily expelled by the briquetting operation. This ore is an especially valuable material for use in the bessemer process. Now the whole of the main market of England is permanently dependent on ores of this class. It is well known that the low-phosphorus Spanish ores upon which a chief part of the English steel industry rests are beginning to become exhausted; that while there are still very considerable quantities of ore there, they are no longer largely adopted for the bessemer process. The quantities available in Algeria are not as great as was once supposed and they are in the interior. Grecian low-phosphorus ores are high in chromium, to which England objects.

The bessemer ores of Kiruna and the export fields of other parts of Sweden are restricted for foreign markets and are liable to become still more so, by action of the government.

Were England inhabited by a people differently constituted the construction of new works for the acid bessemer process would long ago have ceased, but the conservative nature of the English mind has not yet permitted a step that would reduce to any considerable degree the proportionate preponderance of bessemer over other steels, so that the country will require a constant quantity of non-phosphoric ores for a long period. Sydvaranger has now a daily capacity for treating 2,400 tons of ore per day; at 300 working days per year this will give an annual product of about 300,000 tons; when the works have been increased to the capacity expected, that is to 6,000 tons per day, the annual product will be be-

tween 800,000 and 900,000 tons, surely not an overwhelming amount to supply the market that is open to such a material at the proper price.

Travel in this region is inexpensive and, during the summer season, it is delightful. Staunch and convenient steel passenger ships ply from British and Scandinavian ports to Hammerfest, and the local steamers are fair. A *de luxe* tourist express train runs from Stockholm to Narvik several times each week, and the sea voyage from there to Varanger fjord is but three or four days. One sees the midnight sun and even the tourist catches a glimpse of the life of a brave, unpretentious and patriotic people, wresting their livelihood from a forbidding sea and a frozen land. The cost of travel is slight, the trip from Trondhjem to Sydvaranger and back to Narvik is but about \$40, including meals and berth, while the distance is 1,400 miles.



RELATIVE ECONOMY OF VARIOUS TYPES OF DRAFT EQUIPMENT

By T. F. J. Maguire

II. INDUCED MECHANICAL DRAFT

In a preceding article published in our March issue Mr. Maguire discussed stack installations for natural draft. A following number will take up forced-draft apparatus, from the standpoint of comparative economy, and a supplemental paper will be devoted to the economizer.—THE EDITORS.

THE necessary draft intensity required to operate a boiler plant is sometimes supplied by mechanical devices designed to draw the gases of combustion through the furnace and boiler setting. The installation usually consists of centrifugal fan (or fans) with the fan suction connected to the boiler side of the breeching and the discharge end to the stack. With such an equipment the fan creates sufficient draft intensity to overcome the losses in the furnace, boiler, and breeching. The fan discharges into a stack, the height not being based upon any consideration of draft, but being made sufficient to discharge the gases into the atmosphere at such a height as not to be objectionable.

The fan is usually driven, either directly or by means of a belt, by a steam engine or an electric motor. Owing to the fact that the temperature of the gases handled by the fan is 450 degrees F. or more, the steam engine seems to be the preferable type of unit to adopt, especially for direct-connected units. The speed variation required for a mechanical-draft equipment is more easily and reliably made with a steam engine than with an electric motor. The type of engine used is usually the horizontal or vertical single-cylinder, throttling, reciprocating engine and the speed of the fan is automatically

controlled, so as to maintain a practically constant steam pressure in the boilers at all rates of driving within the capacity of the equipment. Of course, the same automatic control of the steam pressure may be maintained with a stack and a suitable automatic damper regulator.

For fan wheels in induced-draft installations, a diameter of 180 inches may be taken as a limit frequently found, though larger fans are satisfactorily used. For a given size of fan, the pounds of fuel burned per hour depend upon the draft intensity required. Assume that a fan of 180-inch size is the largest available, and that the fan must develop a pressure of 1 inch of water column, the fan would handle 146,000 cubic feet of gases per minute and, on the basis of 19 pounds of gases per pound of fuel, would burn 19,000 pounds of fuel per hour. If the fan had to develop a pressure of 2 inches of water column, then the gases handled per minute would be equal to 206,000 cubic feet per minute and the fan would burn 27,000 pounds per hour. If the coal used in both cases developed an evaporation of 7.0 pounds of water from and at 212 degrees F. per pound of dry coal, then the fan in the first case would take care of a maximum boiler horse power of 3,850 horse power and in the second case 5,480 horse power. The speed of the

fan for the first case would be about 120 r.p.m. and for the second case 170 r.p.m. It is therefore evident that in large boiler plants, where induced mechanical equipment and stacks are equally applicable, the mechanical equipment will cost proportionally more than in smaller plants.

The selection of an induced-draft equipment will depend upon its economy as compared to a stack or to a forced-draft installation, and the economy of the former is vitally affected by the power required to operate the fans. If the average temperature of the gases is assumed at 500 degrees F., the power required to drive the fan may be represented by the following simple formula:

$$P = 0.00032 Q h$$

in which P is the average brake horse power delivered to the fan shaft, Q is the average cubic feet of gases handled per minute, and h is the pressure developed by the fan in inches of water column. This formula assumes a fan efficiency of .40. If the friction loss in the engine driving the fan is taken at 10 per cent and the steam consumption of the engine is assumed at 45 pounds per indicated horse-power hour, the steam consumed by the induced fan equipment per hour (w) is as follows:

$$w = 0.016 Q h \text{ pounds}$$

If the coal used evaporated at actual boiler pressure, E pounds of water per pound of coal, then the steam generated by the boilers per hour (W) is as follows:

$$W = 0.13 Q E \text{ pounds}$$

and the percentage of the total boiler output used by the fans (P) is

$$P = 12.3 \frac{h}{E}$$

Of the entire steam generated by

the boilers, the percentage used by the fan of the induced mechanical equipment varies directly as the average pressure created by the fan and inversely as the evaporative power of the fuel. It would seem from the above equation that the induced mechanical equipment would show much better operating economy with a high-grade bituminous coal than with any other coal, and that a relatively poor operating economy would result with an anthracite buckwheat.

As induced mechanical-draft equipments are frequently used in plants not employing economizers, it is natural to inquire the reason for the use of this apparatus, instead of using a stack. The mechanical equipment is more troublesome to operate than a stack and requires considerably more care and attention; it is also not to be compared to a good stack for reliability, so that it is evident that the reason for its use must be that it is regarded as more economical than a stack. In order, then, for an induced mechanical-draft equipment to be preferred over a stack, for a proposed installation, it must show a less annual cost for the time for which it is needed.

A stack installation in connection with economizers* of course must be powerful enough to operate at the low temperature of the gases available for the production of natural draft. There is at least one field, however, in which the induced mechanical-draft equipment has no real competitor and that is for plants using economizers; a forced-draft equipment is not suitable for the purpose. Another field in which the induced-draft equipment is available is in old plants where an increase in the load or a different kind of fuel requires more draft intensity than is available with the stack in use. Other

*Power plants of the largest size, especially, are almost all natural-draft installations.



A RECENT INDUCED-DRAFT FAN INSTALLATION, STILLWATER PRISON, STILLWATER, MINN.
B. F. Sturtevant Co.

considerations may preclude the remodeling of the stack to obtain the necessary draft, in which case an induced-draft equipment affords a satisfactory solution. Where low-grade or high-carbon fuel is contemplated

can be readily answered. However, in answering this question, it must be remembered that each type of draft installation must be based upon the same plant data, namely the maximum boiler load that the plant will



INDUCED-DRAFT INSTALLATION FOR A PORTLAND-CEMENT WORKS

Double fan equipment, 19 ft. 6 in. wheels; Green Fuel Economizer Co.

for use in a new plant, the proper stack for the conditions may be impracticable on account of excessive height, and the induced-draft equipment affords a means for obtaining the proper results. In the last two cases, however, the induced-draft equipment has a formidable competitor in the forced-draft system.

The question whether to adopt an induced mechanical-draft equipment instead of a stack for a plant where economizers are not to be installed,

be required to carry, and the grade of fuel requiring the greatest draft that the plant will be likely to use during the life of the apparatus.

The boiler horse power required for any given plant is carefully ascertained from a consideration of the steam that will be required. Evidently the number of boilers and their rating should be such as to enable the plant to carry the maximum load and at the same time operate under the most economical conditions for the

average load. The rated boiler capacity of a plant is not determined in any way by the type of draft equipment that may be used. Very frequently comparisons are made between a stack and an induced mechanical-draft equipment, in which less boiler capacity is used for the mechanical draft than for the natural draft. Of course, such a method of calculation is decidedly favorable to the mechanical equipment, but it is, to say the least, misleading. In comparing a stack and a mechanical equipment, the same maximum rate of driving for the boilers should be assumed for both, as well as the same boiler capacity.

The furnace design is, however, dependent upon the draft conditions, and the furnace and stack together must be so designed as to enable the boilers to operate satisfactorily at all times. The function of the furnace and draft equipment is to generate sufficient heat to develop the required boiler capacity, and to do this in as economical a manner as possible. It is evident therefore that the kind of fuel to be used has an important bearing upon the furnace and draft-equipment designs, and great care should be taken in determining the poorest coal (in point of draft) that is likely to be used during the life of the apparatus. Knowing the rated and maximum boiler horse power and the lowest grade of fuel that is to be used, the rate of combustion of the fuel or the number of pounds burned per square foot of grate per hour is readily ascertained, and consequently the proper grate area. The draft equipment, whether it be a stack or a mechanical apparatus must supply the necessary draft intensity to burn the proper amount of coal at the assumed rate of combustion with the boilers operating at maximum output.

It would seem, then, that a just

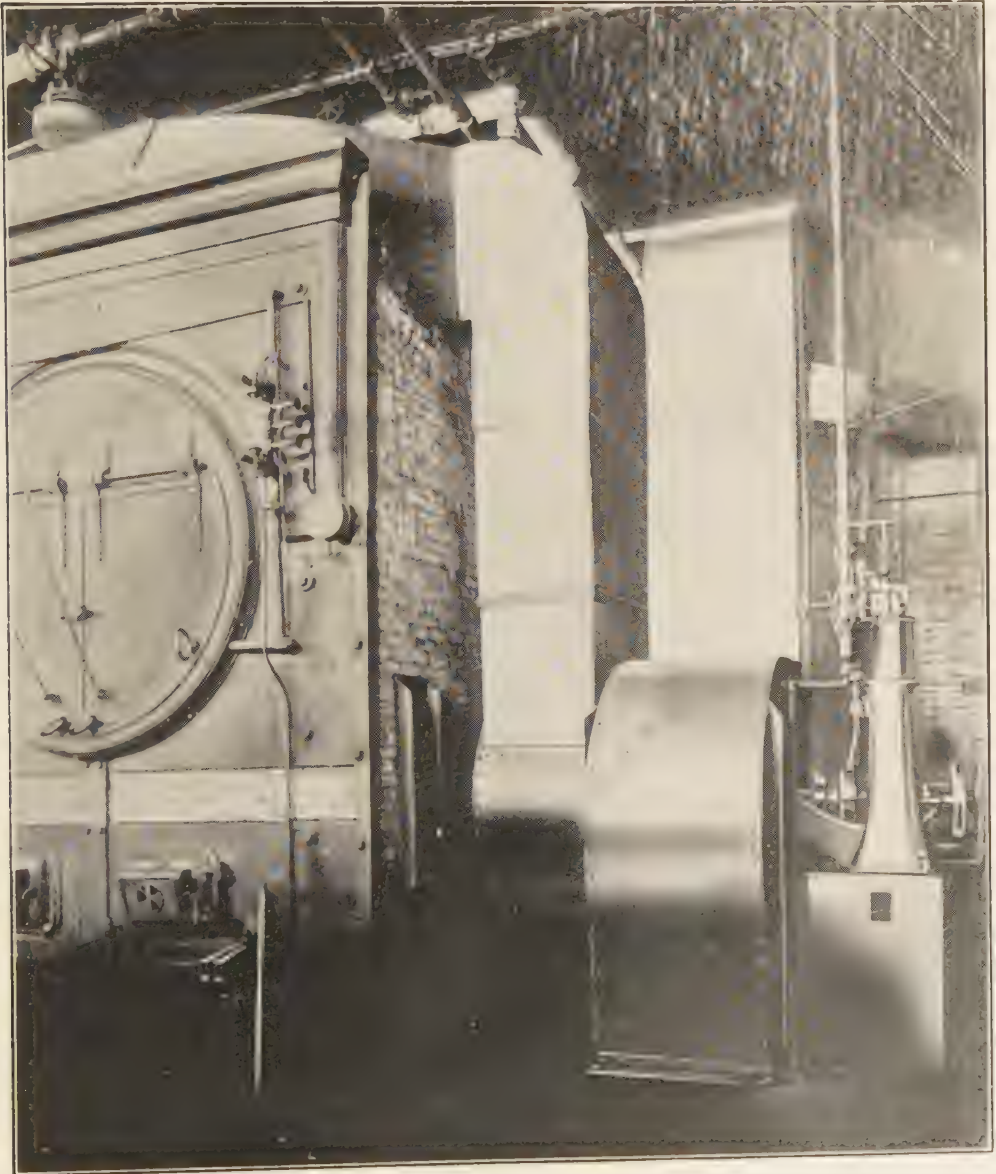
comparison between a stack and an induced-draft equipment, for any given plant, should be based upon the same boiler capacity furnace design, grate area, and grade of fuel.

For a given design of furnace the cost varies with the grate area, and consequently the higher the rate of combustion of the fuel, the less the cost, this being especially so with dutch-oven types of furnaces and automatic stokers. But the higher the rate of combustion, the more costly is the stack as compared to the mechanical equipment. The rate of combustion of the fuel should be as high as is consistent with the type of furnace and grade of fuel, when the boilers are operating at maximum output. A comparatively low rate of combustion at maximum boiler output is poor practice, with natural draft, as it means a thin bed of fuel at light loads on account of the fact that the temperature of the gases in the stack decreases with the load, and hence the available draft at light loads is not sufficient to enable a proper thickness of fire to be carried. A thin fire means poor operating economy on account of the tendency of holes to form in the fuel bed and the heat losses due to chilling of the furnace and excessive air supply. With a mechanical-draft equipment, the draft intensity is independent of the temperature of the gases leaving the boilers and it is therefore possible to carry a fire of the proper thickness, whatever the load, up to the limit of the apparatus. It is possible to do the same thing with a stack, if it is made of sufficient height to develop a high rate of combustion at maximum boiler loads. The matter may be briefly summed up by stating that a proper comparison between a stack and an induced mechanical-draft equipment is based upon the same boiler and furnace equipment and a

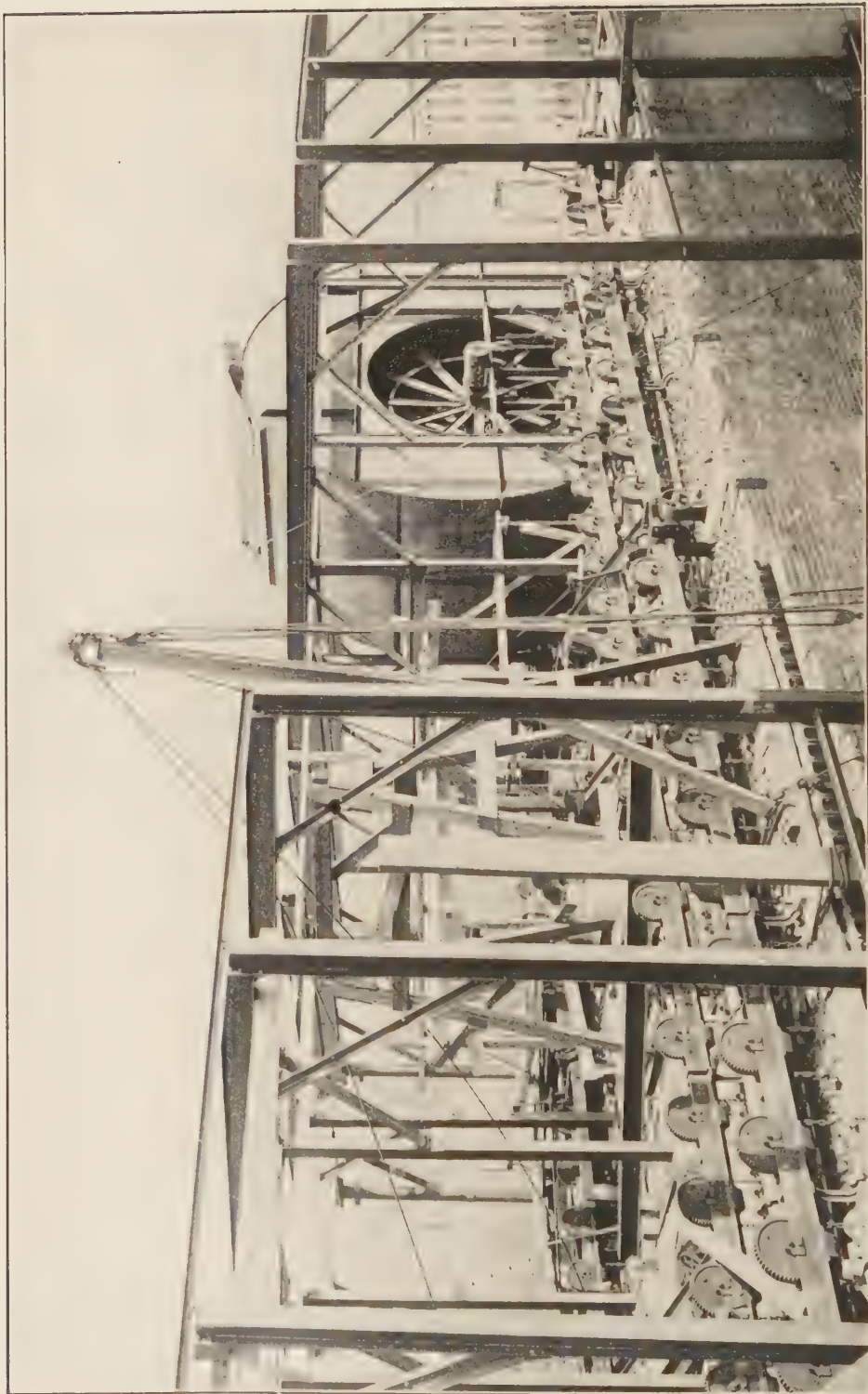
rate of combustion that is as high as is consistent with the kind of fuel used.

In regard to the operating features of the two draft systems (natural and induced) with conditions right, the temperature of the gases leaving the boiler would be the same for the two

and there would be no economical gain of one over the other. It is usually claimed by the manufacturers of induced mechanical-draft equipment that there is a decided gain in the economy of a plant using mechanical draft over the same plant using a stack. The basis for this



INDUCED-DRAFT INSTALLATION, CHICAGO, BURLINGTON & QUINCY RAILROAD, GRAND CROSSING, IND.
Sirocco fan and vertical self-oiling steam engine. American Blower Co.



INDUCED-DRAFT FANS AND ECONOMIZER, MERRIMAC MANUFACTURING CO., LOWELL, MASS. IN COURSE OF ERECTION
Green Fuel Economizer Co.

claim is that, on the average, but 18 pounds of air are required per pound of ordinary coal for the former, while 24 pounds are usually required when a stack is used. This would mean a charge against the stack due to the heat lost in raising 6 pounds of air from the room temperature to the temperature of the gases leaving the boilers. On account of the fact that the draft intensity from a stack varies to a certain extent with the load on the boilers due to the varying temperature of the gases leaving the boilers, it is quite likely that under ordinary conditions of operation the excess air with a stack is greater than with a fan equipment, but with a well designed stack it is doubtful if the difference is as great as given by the above figures. The excess air loss depends a great deal upon the manner in which the fires are handled, and with a fuel bed in which more or less openings occurred the excess air loss would be greater with the fan equipment than with a stack. Assuming, however, that the furnaces are intelligently handled, the heat loss due to excess air should be less for a mechanical equipment than for a stack.

In comparing the two above-noted types of draft equipment the following items must receive consideration for each:—First cost, interest and depreciation charges; cost of repairs; cost of labor and material to operate; economical gain made by the use of the equipment. The following example will illustrate the comparison for a given plant:

A certain boiler plant consists of five 400 horse-power watertube boilers, each boiler being provided with a furnace having 80 square feet of grate area. Upon examination it is found that the poorest grade of coal likely to be used during the life of the plant, is a bituminous slack, capable of evaporating 7.5 pounds of

water from and at 212 degrees F. per pound of dry coal, when the boilers are developing an overload of 50 per cent. Sufficient draft is required to enable the boilers to be operated for considerable periods at 50 per cent overload. For these conditions, the maximum rate of combustion, with 50 per cent overload on the boilers, would be equal to 34.5 pounds of dry coal per square foot of grate per hour, and for this coal and rate of combustion a furnace draft intensity of 0.35 inch of water column should be allowed. Allowing 0.40 inch draft loss in boilers at 50 per cent overload and a loss of 0.20 inch in breeching, the total maximum draft intensity required of the draft equipment would amount to 0.95 inch. A stack 175 feet in height above the grates and 8 feet in diameter would be required. A radial brick stack of this size would cost about \$7,600, and the repair item per year on this stack would be negligible. As no material and labor are required to operate the stack, the annual cost would simply consist of an interest and a depreciation charge.

The most reliable installation of an induced mechanical-draft equipment for this plant would consist of two fans, each of sufficient capacity to take care of the plant, thus providing for breakdown service and thereby eliminating costly shutdowns. Each fan would have to handle about 110,000 cubic feet of gases per minute and develop at this output a pressure equal to practically 1 inch of water column. Two ordinary fans with wheels 156 inches in diameter and operating at a maximum speed of about 140 r.p.m. would be required. The cost of this fan installation complete in every respect would be about \$3,000.

Assume that this plant will operate 10 hours per day and 6 days per week

at an average boiler output of 1,600 horse power. The average dry coal consumed per hour would be approximately 7,400 pounds, and the steam consumed per hour by the fan engine would amount to about 1,000 pounds. An average consumption of about 150 pounds of dry coal per hour would be required to operate the fan. If coal is worth \$1.50 per ton delivered in front of the boilers, the yearly cost of coal to run the induced-draft equipment would amount to \$390 (10 per cent moisture assumed for coal). The additional items of lubricating oils, packing and repairs would easily raise the average yearly cost of labor and material and repairs up to \$450.

If less air is required for combustion purposes with the fan than with the stack, then the fan equipment should have the credit for this economical gain. Allowing 4 pounds less air per pound of fuel in favor of the fan, a breeching temperature of 475 degrees F. (at 1,600 horse-power output) and a room temperature of 70 degrees F., also a heat value of 11,500 B.t.u. per pound of dry coal, the saving made per year by the fan over the stack would amount to \$740.

Now assume that the fan equipment or stack will be required for a period of 20 years. The radial brick stack would easily last the required time but the mechanical equipment would have to be duplicated, in order to cover an operating period of 20 years. At 5 per cent interest, the annual interest and depreciation charges for the stack would amount to \$610, and for the mechanical draft equipment \$388. On the basis of the above figures, the mechanical-draft equipment would be the more desirable, as it would save annually \$512.

The radial brick stack is the most costly of all stacks and a reinforced concrete stack would last the required 20 years. A stack of this type, 175

feet in height and 8 feet in diameter, would cost about \$5,700 and the annual interest and depreciation charges would amount to \$458. The mechanical equipment would therefore effect an annual saving of \$360 over the reinforced concrete stack.

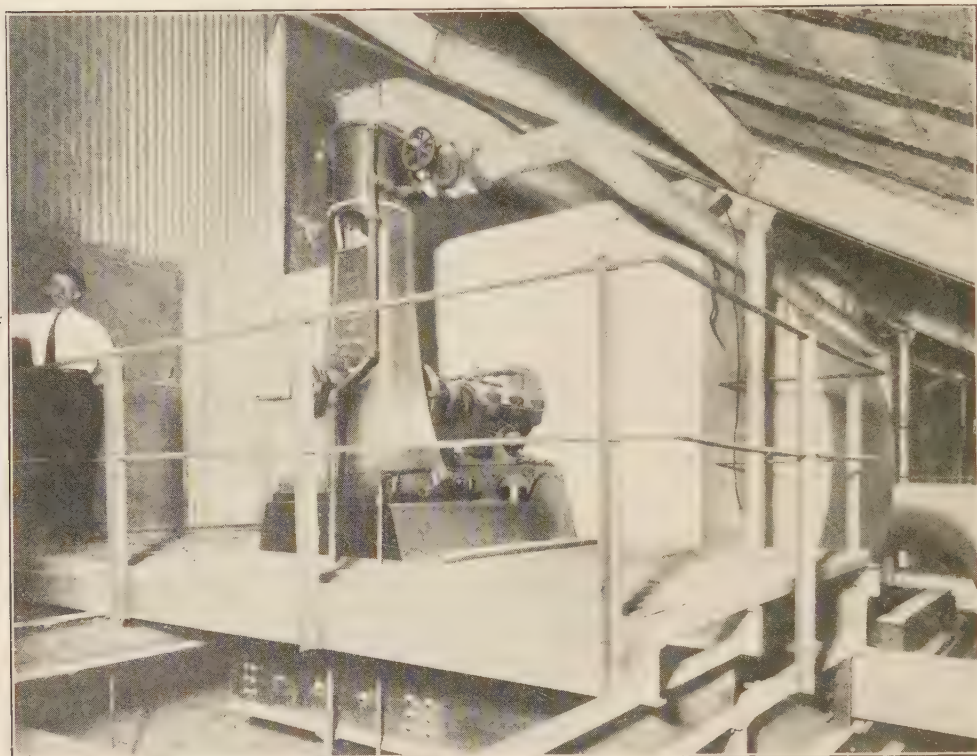
The application of induced mechanical draft for coals and plants requiring excessive furnace draft will be indicated by the following example: A certain boiler plant is to be provided with draft equipment, the capacity of the latter to be sufficient to drive four 250 horse power water-tube boilers for considerable periods at an overload of 33 1-3 per cent. The grate area of each boiler is equal to 1-32 of the heating surface. The coal to be used is anthracite buckwheat No. 3, and it is estimated that this coal will have an evaporative power equal to 7.0 pounds of water from and at 212 degrees F. per pound of dry coal, when the boilers are developing rated capacity. At 33 1-3 per cent overload, the rate of combustion will be equal to practically 22 pounds of dry coal per square foot of grate per hour. A furnace draft of 1.7 inches of water column will be required. Allowing 0.30 inch draft loss in boilers and 0.20 inch loss in breeching, the draft equipment will have to supply a maximum draft of 2.20 inches. A stack is impractical for this plant, as it would have to be 400 feet in height above the grates. If an induced-draft equipment were used, the fan would have to handle a maximum output of 55,200 cubic feet of gases per minute, and to develop at this output a pressure equal to 2.20 inches. A fan with wheel 96 inches in diameter and operating at 350 r.p.m. maximum will be required. With the fan equipment in duplicate, in order to secure the greatest reliability, the cost of the induced-draft equipment would be about \$1,700.



INDUCED-DRAFT INSTALLATION, CHATTANOOGA RAILWAY AND LIGHT CO.
Green Fuel Economizer Co.

Assume that this plant will operate 10 hours per day and 6 days per week, at an average boiler output of 1,200 horse power. The average dry coal consumed per hour will be 6,180 pounds, and the steam consumed by the fan engine per hour will equal 3.3 per cent of the total steam gen-

erated (evaporation factor of 1.1 assumed). If the coal is worth \$1.50 per ton delivered in front of the boilers, then the annual cost of coal to run the induced-draft equipment will amount to \$520 (8 per cent moisture assumed for coal). The additional items of expense, such as lubricating



INDUCED-DRAFT MECHANICAL PLANT, U. S. IMMIGRANT STATION, ELLIS ISLAND, N. Y.

Double-inlet Sirocco fan and vertical self-oiling steam engines. American Blower Co.

oils, packing and repairs, will raise the annual cost of material and repairs for the induced-draft equipment up to \$580.

Assume that the draft equipment will be required for 20 years and that the mechanical equipment will have to be duplicated, in order to cover this period. At 5 per cent interest the annual interest and depreciation charges will amount to \$221. The induced mechanical-draft equipment would therefore cost annually \$801, and this is the figure that would be compared with a forced-draft equipment if both systems were under consideration.

If there were no economical gain due to the use of less air for combustion purposes for an induced mechanical-draft equipment than for a stack, then the former would seldom figure out as economically as the latter, for plants where a stack is a practical proposition. If this economical gain does exist, then the greater the horse power output of the plant, the greater in general, will be the advantage of the mechanical equipment. The proper type of draft equipment is determined only by a careful consideration of the conditions of the plant and no general rule can be laid down for such a selection.



THE WORK DONE AND THE POWER REQUIRED IN ROLLING STEEL

By Harold Wheatley

Power requirements for rolling mills, and the basic data by which these requirements are determined, have been somewhat scantily discussed in modern literature; scantily, at least, in proportion to the magnitude and importance of the subject. We are therefore glad to return to a topic already ably treated in these pages from a somewhat different viewpoint by Mr. J. A. Knesche in our October and November, 1910, issues. Mr. Wheatley has been for eleven years a designer of rolling-mill machinery in the largest American plants. His paper recognizes the latest researches and most modern practice; and where he does not agree with commonly accepted theories, he advances well-considered reasons in explanation.—THE EDITORS.

EVER since Cort introduced the process of reducing hot metal by passing it between rolls, a certain amount of mystery and a great deal of vagueness have enveloped the question of the power requirement for rolling mills.

This is due, to some extent, to the fact that it is a complex subject, not being simply a matter of the force required at a given speed to effect a certain reduction of metal at a given temperature, but involving the power necessary for its reduction under conditions which may vary widely, according to the type of mill, the contour of passes, and the methods of operation.

To say that a mill of a certain size will require a given horse-power drive because it requires that horse-power for another mill of the same size and for approximately the same reductions is not mere guesswork, in that it is based on past performance; but it may be little better than a guess in that it may not be an economical drive, either from the standpoint of the power expended per unit of reduction, the first cost of installation, the minimum cost for repairs, or the loss of tonnage due to breakdowns.

Much valuable light has been thrown upon the matter by power experiments under actual running con-

ditions, but much remains to be accomplished.

It is the purpose of this paper to outline the main factors that affect power consumption in rolling, and the relation of the crushing strength of the hot metal itself to the power actually required at the rolls, and for driving the mill.

The power consumed at the rolls is supplied by the mill engine or motor, directly in the shape of actual twisting force transmitted through the mill coupling, or indirectly as kinetic energy stored up in the moving parts. The engine or motor in turn may be either direct-coupled to the mill or connected by belt or rope drive or gearing. Figure 1 shows a two-high direct-coupled mill which illustrates the typical method of transmitting the power through spindles and gearing to the rolls. There are many different styles of mills, but the principle is the same.

The mill is first put into motion and run up to normal speed before the piece is started between the rolls, this operation taking some little time if the mill runs non-reversing with a flywheel, on account of the inertia of the moving parts.

The piece on entering retards the speed of the flywheel and the other moving parts, and some or all of

their kinetic energy is given up in the pass, assisting the engine or motor by just that much, amounting to as high as 75 per cent or more of the total energy consumed if the pass be a short one. However, the motor tends to bring the mill up to its normal speed again, in consequence of which it supplies more and more of the energy consumed. If the pass be a long one and the mill regains its speed at the beginning of the pass, all the kinetic energy is used up, leaving the motor to supply the power for the remainder of the pass. Should the speed be accelerated slightly beyond this point, the motor will be supplying more power than that required for the reduction plus friction losses, the difference of power being converted into kinetic energy of the moving parts.

The useful or effective work done in any pass is the actual reduction of the metal, and may be measured by the amount of metal displaced in that pass. This displacement, expressed in cubic inches, equals for any pass $A \times L$, in which expression

A = area of reduction or draught in square inches.

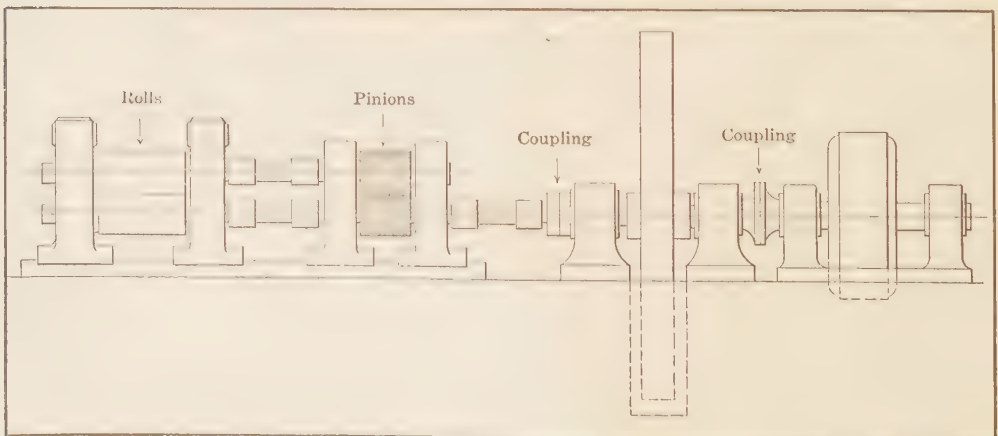
L = length of piece in inches before the pass.

Under rolling-mill conditions, in

addition to the power required for the useful work of displacing the metal, a large amount of additional power is absorbed, or lost, by mill friction, and in the case of closed or partially closed passes, by roll-pass friction, also by the work done in dragging the piece from one side of the mill to the other in case no roller tables or other mechanical means are employed.

Setting aside friction losses, the power required to displace one cubic inch, or any given unit, of hot metal of a given temperature and chemical composition, between two rolls, without any lateral pressure tending to restrain the spread of the metal, is constant no matter what the diameter of the rolls; while the power lost or absorbed per unit by mill friction, roll-pass friction, and the transferring of the bar, varies accordingly to conditions dependent on the design and operation of the mill.

With the mill running at "no load," or when no reduction of metal is going on, only power enough is exerted to overcome the friction due to the inertia of the moving parts; while at "full load," or when reduction of metal is in progress, there is an increased pressure on the bearings on account of the resistance of the bar



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FIG. 1. DIAGRAM OF TWO-HIGH DIRECT-COUPLED MILL ILLUSTRATING POWER TRANSMISSION

to deformation. Friction is thereby increased, if not in direct proportion to the increase of pressure, yet still increased, as bath lubrication (which is practically the only condition under which friction does not increase with the intensity of pressure) cannot be relied on to any extent around a rolling mill running under ordinary operating conditions, especially at the neck bearings where grease is used.

With reference to roll-pass friction, or friction due solely to the contour of the passes restraining the flattening or spreading of metal laterally,

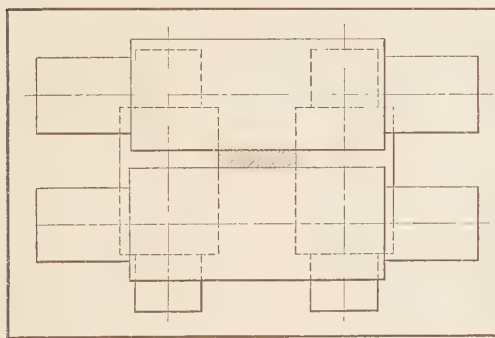


FIG. 2

experiments show that it takes more power for restrained passes; as, for instance, a plate when rolled by a universal mill is restrained by the vertical rolls (Figure 2) or shapes running through grooved passes are confined by the sides of the grooves (Figure 3) than it does for corresponding reductions where the metal is not so confined or restrained (Figure 4).

In the case of a closed pass, or box pass, as shown at A, Figure 3, or the grooved passes, shown at B and C, technically known as "open" passes, in addition to this lateral restraining tendency, the collars exert more or less of a dragging effect on the piece, due to the fact that the bottoms of the grooves revolve more slowly than the tops.

This friction causes power to be

absorbed. It is necessary to proportion passes of this type with reference to those immediately preceding so that the lateral restraining tendency be not sufficient to cause the metal to squeeze out badly between the rolls in the shape of so-called fins, which tend to spoil the product and break the rolls.

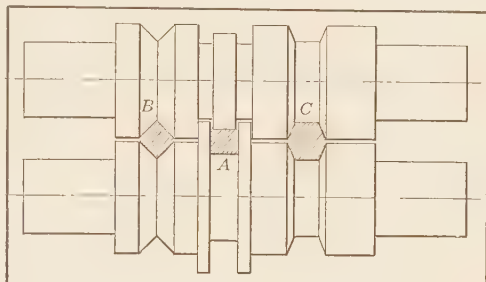


FIG. 3

At the box pass A the metal is closed in on all sides and cannot squeeze out at all, no matter how much it tends to spread. Consequently, the restraining tendency of this style of pass is more than that of an "open" pass, with a corresponding higher power requirement.

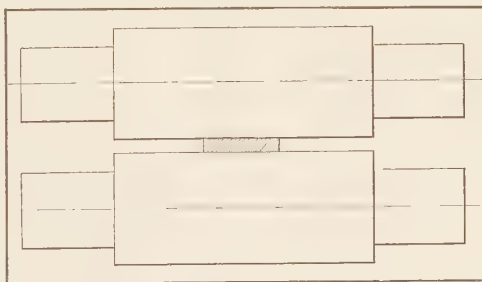


FIG. 4

It may be stated as an apparent exception to the above that a thin flat will take more power per unit of reduction in an unrestrained pass than a more compact section such as shown in Figure 3 in a restrained pass; but this is only because the flat, having more surface exposed than the other for a corresponding sectional area, cools much more rapidly on its way

from the furnace and during the process of rolling, and the higher power requirement is due to this lower temperature. For like temperatures the flat section in an unrestrained pass would require less power per unit than the other.

With reference to the work done in transferring the piece from one side of the rolls to the other, it is evident that if a bar of steel was run through a pair of rolls set just close enough to pinch the bar, the rolls would produce no appreciable deformation of the bar, and yet they would be exerting a certain amount of power to pull it through.

In rolling heavy stock the metal is usually carried into the rolls and out again by driven rollers, so that the mill rolls themselves are relieved of the work of dragging it back and forth. But in small merchant and bar mills, the stock generally does drag, being manipulated by the men at the rolls.

Take the case of a 10-inch merchant mill making a 25 per cent reduction in a certain pass on a bar 30 feet long and $1\frac{3}{4}$ inches square section, and delivering the bar at 600 feet per minute.

The weight of the bar equals 309 pounds. Taking low coefficient of friction of the metal on the mill floor at 15 per cent, the power exerted in dragging the bar along equals 46.35 pounds, which exerted at the rate of 600 feet per minute equals 463.5 foot pounds per second, or a trifle less than one horse power for the given pass.

This power, while comparatively very small, is not exerted in actually displacing metal, and must be set down as a friction loss wherever it occurs, although in practice it is usually ignored as being too small to cut much of a figure.

As was stated previously, neglect-

ing the friction losses just enumerated, the power required at the rolls is the same irrespective of the roll diameters, although in actual practice it might take slightly more for relatively large rolls on account of the rolls themselves and some of the other moving parts being heavier. However, there is an opinion prevalent that for corresponding reductions large rolls require more power than relatively smaller ones, *per se*, and irrespective of power lost through friction.

It is evident that taking a given mill with certain size rolls for a stated reduction, if larger rolls were substituted, considerably more force would be required at the mill coupling to maintain the same number of revolutions per minute. But, on the other hand, the reduction of metal would be carried on at a correspondingly faster rate on account of the greater surface speed of the larger rolls, so that the power required per unit of reduction would be the same as for the smaller rolls.

Various attempts have been made to account for this seeming discrepancy, as for instance the statement in one treatise on the metallurgy of steel that the difference of power requirement in favor of small rolls is due to the fact that they cause less spreading of metal than those of larger diameter. This is no doubt true when the spread is confined in a closed or restrained pass or by vertical rolls, but in reductions where there is no lateral restraining tendency, the actual power required for reducing the metal is no more for large than small rolls.

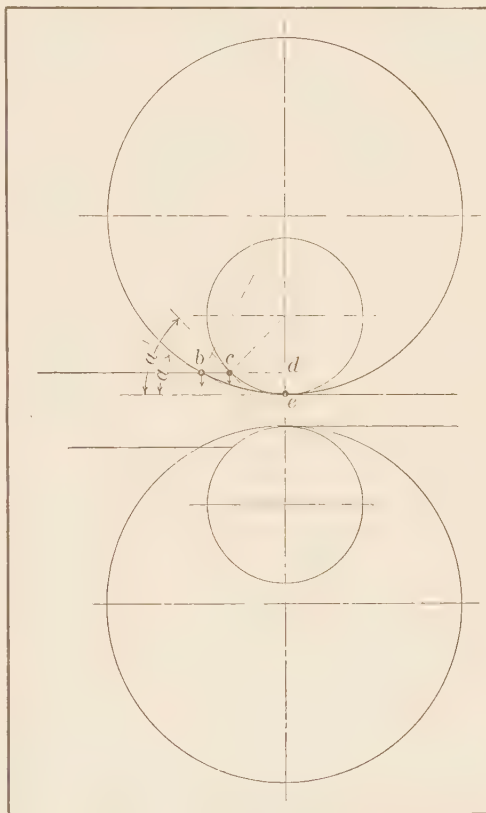
Another reason advanced is that smaller rolls require less power because the area of metal under vertical pressure is less. This can be clearly seen by referring to Figure 5, where $c d$ multiplied by the width of bar or

piece being reduced equals the area under vertical pressure of the small roll, and $b d$ multiplied by the width of piece equals the area under vertical pressure of the large roll. However, to compensate for the greater area under vertical pressure of the large roll is the fact that the large roll attacks the metal at a more favorable angle. For every point along both arcs of contact $c e$ and $b e$ may be considered to have both a rotative and a vertical downward motion. Let the reduction and the time required for it be the same for both rolls; then their surface or rotative speeds will be the same. The vertical downward speed of any contact point equals sine a multiplied by the rotative speed, a being the angle which the tangent to the roll circumference makes with the horizontal. The angle a for corresponding points on both rolls becoming smaller with the increasing diameter of the roll, it follows that the vertical downward speed of any contact point, as b on the large roll, is less than that of c , the corresponding point on the small roll.

Therefore, any small contact surface of the large roll, as that represented by the point b , is doing less work than a corresponding surface on the small roll represented by c , since b at any given instant is moving vertically downward more slowly than c through the same resistance.

Another reason given for a smaller power requirement for small rolls refers to surface friction. A bar of steel subjected to the squeezing action of a pair of rolls is not made appreciably denser, but squirts out in front somewhat ahead of the surface speed of the rolls and is retarded in back, being drawn in only as fast as it can be squeezed out. Thus there must be one place along the arc of contact where the speed of the piece is that of the roll surface, while in front it is greater and in back less, causing a

slipping or rubbing action over the contact surface. While with large rolls, for corresponding reductions, the surface exposed to this rubbing action or surface friction is greater, yet the intensity of downward pressure per unit area is correspondingly



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FIG. 5

less than for relatively smaller rolls with no advantage in favor of the latter.

In addition it has been pointed out that certain experiments have shown that the power required for mills with large-diameter rolls and relatively thin pieces is greater than for those with thicker pieces and relatively small diameter rolls. But in these experiments the temperatures as read by the pyrometer were higher in the latter cases. This fact would be sufficient in itself to account for the discrepancy, especially as in such

comparisons the difference in temperatures is very apt to be greater than appears on the surface, for the reason that the temperature of a plate or thin slab will be comparatively uniform throughout, while the core of a thick ingot or slab will be hotter than the surface, being protected from the cooling action of the air by its outer layers.

Having noted the various power losses incidental to reduction in the rolls, and the relation of roll diameters to power requirement, it will be in order to examine into the resistance offered by the hot metal to deformation and the force actually exerted upon it by the rolls (irrespective of roll diameters or the power losses enumerated) with the consequent reactions of the neck bearings and housings.

From the standpoint of power requirement there are, broadly speaking, two types of passes—those in which straight reduction is carried on, and shaping passes in which the section is merely modified in form with very little reduction in area.

It is only the first type that need be analyzed here, as the power consumed in merely changing the shape of a section is chargeable to roll-pass friction. In a pass of this first type, although the motion of the rolls is rotative, the actual work done is one of compression or crushing, the metal being squeezed down from its original thickness T to the least distance between the rolls T_1 , Figure 6. The resistance of its molecules to deformation is normal to the length of the piece or vertical. The maximum resistance is encountered by each roll at the point of entry, m , while at O it is zero, the reduction being completed at this point. Along the arc of contact of either roll from m to O the resistances vary from maximum to minimum, and may be

represented in magnitude and direction by vertical lines, as shown, drawn from the arc to the line no , the edge of the reduced piece prolonged, the length of each line measuring the thickness of metal being crushed down at any instant by that part of the roll intersected by it.

If a point on the arc of contact of either roll be so chosen that the sum of the moments of all the resisting forces acting about the one side of a vertical straight line passing through that point, be equal to the sum of the moments on the other side of the line, this point may be taken as the point of application of a force equal to the summation of all the resisting forces along the arc, which for each roll equals $C \div 2$, if C equals the total resistance of the metal to deformation. In other words, this force is the resultant resistance and acts in the same direction as its components.

The vertical straight line representing it is the vertical neutral axis of the section $mdon$, which would be located one-third the distance no from the vertical line mn were the section a triangle bounded by the straight line mo instead of the arc mdo . For the required section $mdon$, its location can be found by the formula.

$$X = \frac{(A \times a) - (B \times b)}{A - B}$$

In which

X = normal distance of vertical neutral axis or the line of action of the resistance of metal C from mn .

A = area of triangle mon .

a = normal distance of centre of gravity of triangle from mn = $1/3 no$.

B = area of segment.

b = normal distance of centre of gravity of segment from mn = $1/2 no$ (very nearly).

To overcome the resistance $C \div 2$ offered by the metal to each roll, there are two forces acting at the point of contact, d , Figure 7,—the tangential pressure P due to the horse power exerted by the rolls, and the force R acting through the roll center. R represents the reaction of the roll-neck bearings and housings, neglecting the dead weight of the roll itself which would be added in the case of the top roll and subtracted for the bottom.

If one of these forces, as P , is known, the other two can be determined by a polygon of forces as shown, and the force R in turn be resolved into the component horizontal and vertical reactions of the neck bearings and housings.

P the tangential pressure can be found by the formula:

$$P = \frac{HP}{rN}$$

Where $HP \div 2$ equals half the total horse power required for the actual work of reduction, which equals half the total horse power required to drive the mill minus friction losses. Of this more will be said later on.

r = radius of roll in inches.

N = number of revolutions per minute.

These various quantities can be calculated in terms of P as follows:

$$\frac{C}{2} = \frac{P}{\sin \theta}$$

$$R = P \times \cotan \theta$$

$$R_1 = P \times \cotan \theta \times \sin \theta$$

$$R_2 = P \times \cotan \theta \times \cos \theta$$

If the forces P and R for each roll were replaced by a single force $C_1 \div 2$ acting normal to the piece at the point d , and equal and opposite to $C \div 2$, the effect in reduction of metal would be the same, setting aside as before the friction losses, and the horse power required per

given reduction would be the same. For

(1) Twisting moment of P about roll center = $P \times$ roll radius.

(2) Twisting moment of $C_1 \div 2$ about roll center = $(C_1 \div 2) \times a c$, the normal distance from the line of action of $C_1 \div 2$ to roll center.

But $C_1 \div 2 = P \div \sin \theta$, since it is equal through opposite to $C \div 2$ and $a c =$ roll radius $\times \sin \theta$.

Substituting these values in equation (2) we have

(3) Twisting moment $C_1 \div 2 = (P \div \sin \theta) \times$ roll radius $\times \sin \theta$, or

(4) Twisting moment $C_1 \div 2 = P \times$ roll radius.

Comparing equations (1) and (4),

Twisting moment of $P =$ twisting moment of $C_1 \div 2$.

Therefore the actual power required for a given reduction of metal, independent of friction losses, is the same whether the force is applied directly or rotatively.

In a hydraulic forging press, the work done in compressing an ingot is accomplished by direct downward pressure and is analogous to that done where the metal is reduced in the rolls. The rule is that for a given power exerted, the same volumes of metal are displaced (neglecting friction losses) notwithstanding the difference in the method of applying the force in each case.

In this connection it may be stated that the hydraulic press has actually been used as a sort of blooming mill, with satisfactory results in breaking down ingots from say 18 inches square to about 8 inches square, so that their further reduction may be affected in a moderate sized mill.*

The friction losses on a regular blooming mill are particularly severe on account of the heavy moving

*The Hydraulic Press as a Blooming Mill.—*Iron Trade Review*, Nov. 24, 1910.

parts of the mill proper and of the engine when made strong enough to stand the shock of continual revers-

the rolls, irrespective of friction losses, could readily be found if the crushing strength of the metal were known in terms of the power required per given unit of reduction, at different temperatures and different degrees of hardness due to chemical composition.

So far as I know, no experiments have ever been conducted with the object of determining this in a direct manner. It is true that many important and valuable experiments (notably those of Mr. Knesche, described in THE ENGINEERING MAGAZINE for October and November, 1910, and those of Dipl. Ingenieur

Puppe, and by various steel companies), have been made on actual rolling mills, the result of which ex-

pressed as constants show the amount of power required for the reduction of a given unit of steel on different types of mills for various shapes.

These constants show well defined increases of power for decreasing temperatures. But the irregularity and non-uniformity of the increases indicate that the constants represent not merely the resistance of the hot metal to compression, but other factors more or less variant, such as the power absorbed by roll-pass friction, and to a certain extent the power absorbed by mill friction which is not altogether accounted for by subtracting the work done at "no load" from that done at "full load."

However, these experiments and these results give a sufficiently close basis for deciding upon the power required for driving actual mills, as the engines or motors are generally selected of a capacity considerably in

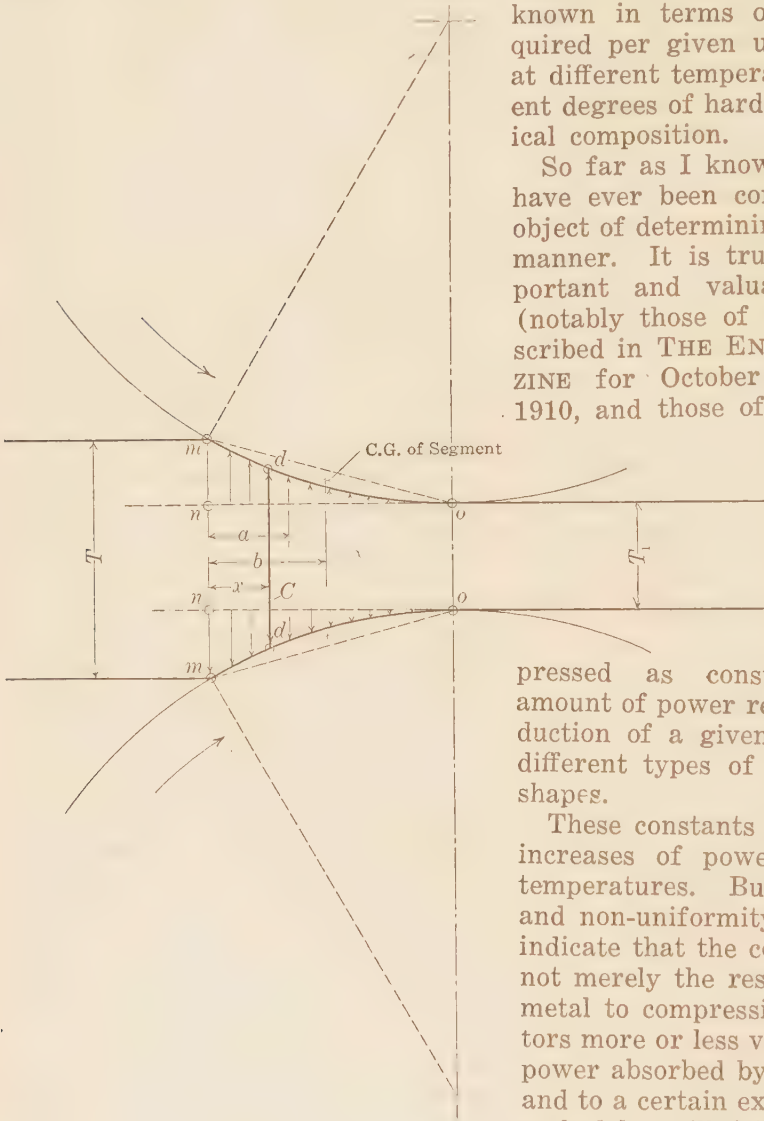


FIG. 6

ing. This, added to the fact that the engines run non-condensing on account of having to reverse, makes this type of mill uneconomical from the standpoint of ratio of power required to actual work done.

The power required for a rolling mill actually to reduce the metal at

excess of the power actually figured as being required. This is done for the reason that the problem is not

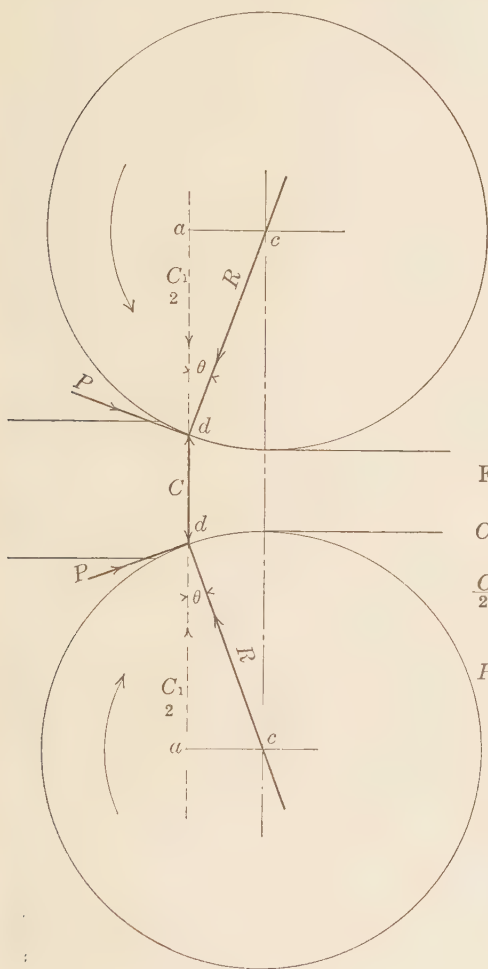


FIG. 7

simply what size engine or motor will be strong enough to drive the mill and reduce the metal, but rather what size will do the work with the smallest inconvenience and loss from breakdowns. For in case of even a short stoppage for repairs the cost of the actual part or parts to be replaced or "patched up" is usually very small compared to the loss of tonnage involved.

The writer has in mind the case of a 40-inch blooming mill driven by an engine which, while theoretically

strong enough to do the work, was a source of annoyance and loss from frequent breakdowns, the bed plate cracking and the connecting rod breaking within a short space of time. A much larger engine, approximately 25,000 horse power, was installed and no further trouble occurred.

Just how much or how little of the increment of surplus power shall be provided in any given case depends on the judgment of the designer and the type of mill. However, if the crushing strength of high and low-carbon steel at rolling temperatures,

Force Polygon for Top Roll.

C = Total Resistance of Metal to Crushing.

$\frac{C}{2}$ = Resistance to each Roll.

$$P = \frac{63025 \times \frac{HP}{2}}{rN}$$

say from 1,400 degrees to 2,400 degrees Fahrenheit, were determined by experiment in terms of the power required in foot-pound-seconds per unit of displacement, it would give a more definite basis for determining the power required for any given reduction of metal whether in the rolls or otherwise.

If the unit of displacement of metal be taken as one cubic inch and the power in foot-pound-seconds per unit be designed as Cu , then the power, exclusive of friction, required to displace any given amount of metal at a given temperature could be found by the formula:

$$\text{Horse power} = \frac{V C u}{550 t}$$

In which

V = volume displaced in square inches.

t = time required for the displacement in seconds.

Since the power is the same for the same displacement or reduction, exclusive of friction, whether the force acts in a straight line or rotatively, this equation would hold good for the power required for displacing the metal in a rolling mill exclusive of the power absorbed by mill and roll-pass friction.

For any given reduction in the rolls V in the above equation would equal AL , A being the area in square inches of reduction or draught, and L the length of the piece in inches before reduction. Although Cu represents only the unit power required, exclusive of friction, for which results obtained by the above equation would always have to be corrected to obtain the power required to drive an actual mill, yet it could be made a useful basis of comparison and point of departure. For by comparing this actual unit power requirement Cu , which would be a constant for the same temperatures and compositions of metal, with a similar unit of power required for mills of different types having unrestrained passes, the difference between the two would show the power lost in mill friction at "full load," which would in all probability be a different quantity from the power required to run the mill at "no load" for the reason indicated previously. These differences could be expressed as increments of the constant Cu for the different types of mills.

By comparing the unit power requirement on a mill having open or unrestrained passes, with the unit power requirement for the same mill running with restrained passes, the increment of power absorbed in various different closed or partially closed passes could be established and further expressed as increments of the power constant Cu for the different contours of passes. Cu itself

would equal the actual power per unit of reduction, and increments of Cu the power lost by friction. Then it could be determined, within a close approximation what power would be required for any reduction in a given style of pass and type of mill by using this constant Cu augmented by its proper increments, the formula reading:

$$\text{Horse Power} = \frac{(Cu + Cmf + Crp) RL}{550t}$$

In which Cu =as before the crushing resistance of the metals in terms of the power required for displacing one cubic inch.

Cmf =mill friction increment in foot-pound-seconds per constant Cu for the given type of mill.

Crp =roll-pass friction increment (should the pass in question be restrained) in foot-pound-seconds per constant Cu .

R and L would have the same values as before, their product representing the cubic inches of metal displaced, if one cubic inch be taken as the unit of displacement.

Tabulated values of the constants Cu in connection with their proper mill friction and roll-pass increments would give an opportunity for efficiency comparisons between different types of mills and comparisons of different methods of lubrication on the same mill in reducing the mill-friction losses. They would also give the roll-pass designer useful information as to the relative economy of different contours of passes.

The knowledge of the power actually required to reduce the metal as furnished by constants Cu would give a definite basis for resolving the force exerted at the periphery of the rolls into the resulting stresses on the housing, chucks, cap bolts, etc.

Displacement experiments along these lines would determine definitely whether it takes more power to re-

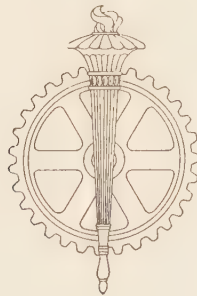
duce hard steel at high temperatures than medium or soft at the same temperatures. About this point there is a difference of opinion, some inclining to the belief that it does not. However, in this connection it may be mentioned that about twelve years ago Mr. Henrich V. Loss, on certain shear tests found that it took from 14 per cent to 25 per cent more power to shear hot steel (from 1,800 degrees to 2,500 degrees F.) with 1 per cent carbon and 130,000 pounds ultimate strength, than to shear at corresponding temperatures steel of 0.20 carbon and 70,000 pounds ultimate. (*Iron Age*, Feb. 15, 1900). From which there might reasonably be inferred a somewhat higher power requirement for the displacement of high-carbon steel at corresponding temperatures.

Occasionally a piece of steel will stick in the rolls and stall the mill or break a spindle or roll when other pieces of steel from the same "heat" and approximately the same temperature have gone through the same pass just previously without trouble. While this is due to a difference in

power requirement, it is not that more power is actually required at the rolls to reduce the metal but that more power is absorbed by friction, probably on account of a roll neck getting hot and greatly increasing the power absorbed through friction, by expanding slightly.

To sum up, the friction losses on rolling mills are so variant that the power constants derived from experiments on actual mills are not true indexes of the power required per unit of displacement actually to reduce the metal, although they may serve fairly well as guides in the selection of suitable mill drives.

If the crushing strength of hot steel for different temperatures and compositions were determined by experiment in terms of the power required per cubic inch or other unit for its displacement, the values obtained would serve as a basis for the accurate determination of friction losses, the horse power of mill drives, give opportunities for efficiency comparisons, and in various other ways be of use to the mill man and designer.



MODERN ORGANIZATION

IV. FALLACIES OF ACCOUNTING

By Charles DeLano Hine

Major Hine's most interesting and thought-stimulating statement of a new view of modern organization began in our January issue with an outline of the "unit system" as applied on the Harriman Lines. His second paper, "Broadening the Ideals of Line Supervision," emphasized the reasons for the effectiveness of some of the measures defined in the first. The third installment attacked certain fundamental characteristics of ordinary present-day practice, pointing out that even the cherished institutions of efficiency must be balanced by complementary forces if the true path of progress is to be followed. Now, with increasing definiteness, he applies this argument to the specific cases of accountancy and permanent special staff, offering a new interpretation of the nature of both functions and new suggestions for their administration to the greatest advantage of total efficiency.—THE EDITORS.

SO rapid has been the growth of modern industry, so extensive is the volume of activity, so imperative is the necessity for a check of some kind against extravagance and corruption, that accounting as a function has assumed an importance far beyond its true proportion. Accounts are but a measure of performance, not performance itself. Accounts are but a yardstick. So prone is human nature to mistake incidentals for essentials that through long use the yardstick acquires a fictitious value. Experience, up to the period of obsolescence, ripens the human being and increases his efficiency. The yardstick, however, like most inanimate things, after being once properly tested is none the better for having made ten-thousand measurements. This failure to distinguish between the animate and the inanimate finds extensive expression in the interior organization of modern society.

The accountant attempts to tell us that money has been legally and honestly expended. He is usually powerless to say whether or not the expenditure has been efficient and therefore economical. Any one can make vouchers match and columns balance if he fudges long enough. It

is not every one, however, who can organize and direct the divine forces of nature, divine because they are human. At the outset too often the engineer of men finds himself handicapped by the purveyor of figures. Efficiency too often is measured by book balances and statistical reports rather than by expert inspection of actual conditions and performances.

Class consciousness is as expensive industrially as it is undesirable sociologically. The accountant, being human, exaggerates his own specialty, and gets away with the proposition because the director of men and things may scorn to meet the accountant with the latter's weapons. Organization as a science demands that the two get together, not in combat, but in co-operation. When he wakes up, the technical director has all the advantage. He can learn accounts much more easily than the accountant can acquire technical knowledge. A concrete application of this principal is found on some railways, including the Harriman Lines and the Pennsylvania System. There, the disbursement accounts are kept by geographical operating division under the direction of the responsible operating officer, the division superintendent. The underlying theory is

that accounts as part of every-day working tools should be available first hand for prompt and effective measure of performance; that it is manifestly unfair to expect to hold officers responsible for results and at the same time deny them first-hand knowledge of existing conditions. On most railways and in many other large industrial corporations, accounting is regarded as a sacred mystery beyond the ken of the every-day operating man. The result of such illogical specialization is reflected in a remote centralization of function. The scorer is too far from the game. Individual batting averages acquire a greater relative value than sacrifice hits which may bring in winning runs.

One of the reasons that banks enjoy the general confidence of the public is because of their highly localized operation. The greatest financial institutions work only through more or less individualized correspondents. Each bank is made a complete, self-contained unit under a president or manager, who controls directly and completely his bookkeepers. If banks had fallen into the fallacy of the industrial world, all the bookkeepers would report to a head bookkeeper in a distant city and all the janitors to an alleged expert chief janitor somewhere else. Much of the local feeling of distrust against the American Telephone and Telegraph Company and its later subsidiary, the Western Union, is traceable to the fact that in few cities is there a recognized head of the company. The work is divided up amongst specialists, who for a time, by increased and intense attention to certain details, are able to show high departmental performance. Complaints of one sort or another may be met with the statement that some other department is responsible. The

dissatisfaction of the public sooner or later finds expression in a demand for increased regulation of rates, or public supervision of service through commissions or otherwise. A corporation as an artificial person suffers enough lost motion from lack of inherent red blood without further emphasizing its vulnerability by a conscious or unconscious shifting of responsibility through mistaken notions of the proper division of labor. By all means there must be some division. Where the efficiency doctors disagree is mainly as to the point of complete convergence of activity and authority.

It is a far cry from the old-time watchmaker who wrought every part himself, to the factory operative who knows one machine turning out a very limited portion of the works of the finished watch. Were the making of watches the chief end of man, the highly segregated activity would be ideal. There are so many other things requisite, however, to insure life, liberty and the pursuit of happiness, that true composite efficiency demands, at least, such rotation of function as will prevent the dwarfing of individual development.

Corporations, like society in general, cannot stand still. They must and do advance. The sins of ignorance in one generation find absolution in the more enlightened practices of the next. It is predicted that ere long corporations will so see the light as to reduce accounting to its proper position. Accounting is one of several components of operation, not an independent function in itself. Too often confusion comes from calling the accountant an auditor. The accountant should be a registrar, the auditor a reviewer or inspector. Here is a distinct differentiation of function. Constructive criticism and review have a distinct function. He

who criticises or reviews, be he ever so honest, must be able to suggest practicable improvement, otherwise his criticism degenerates into harmful carping. It follows, therefore, that the inspector must be an expert operator. Audit is one of several components of a broader activity, inspection. The fundamental defect in many modern corporations is in endeavoring to make the accountant an auditor, to check the books before they are made up. This results in one-sided development and more or less unconscious fudging of operation to meet rigid preconceived notions of accounting requirements. Patrons would soon leave in disgust a bank whose teller had his efficiency measured by the bookkeepers farther back from the counter. The teller of necessity relies upon the record of the bookkeeper to protect the bank against the mistakes or designs of the customer. In a small bank one may be both teller and bookkeeper. Later on the work is divided, not because the bookkeeper is considered more honest than the teller, but because there is more work than one man can do and there is a self-suggesting division of labor. The underlying principle is that volume of activity rather than importance of function defines planes of cleavage in the division of labor. Frequently this basic principle is forgotten and class consciousness encourages the belief that segregated activity derives its existence from highly technical knowledge. Organization as a science has a hard task to overcome by proper checks and balances this feeling of "we are so different" and "our work is very expert and peculiar."

The problem mentioned is receiving a practical solution in a variety of ways. The primal instinct of self preservation is prompting engineers

to learn more and more of accounting. Some of the large New York firms of efficiency and production engineers are developing accountants from young engineers. Whether or not the accountant of the future is an engineer, it is certain that the engineer will be an accountant. Where the public accountant leaves off and the muckraker steps in saying that something is wrong, the efficiency or production engineer stands fast and produces improvement. A prerequisite to a knowledge of physical engineering is a grounding in mathematical conceptions far beyond those necessary to cover every phase of financial accounting.

The accountant begins by flattering himself that because entrusted with records of financial transactions, he is more honest than the common run of people who deal with men and things rather than with money. By an easy process of extension this idea is developed into a belief that all the employees connected with the accounting department are perforce of a superior degree of integrity. Apart from the baneful subjective effect of so absurd a fallacy is the objective resultant. Robbed of part of his working tools, denied by inference the fundamental requisite of integrity, the operating man sub-consciously acquires an attitude of defence or of indifference. In either case there is a distinct loss of composite efficiency through failure of the organization to co-ordinate properly all the human elements engaged in the particular activity. There results a condition of having a junior clerk in a distant office question the acts of a highly paid officer on the ground. The presumption should be in favor of the latter, but because efficiency is necessarily relative and intangible, the clerk has a decided advantage of

position because he measures performance from his little viewpoint with a seemingly tangible report and an apparently effective unit of comparison. This undesirable condition is highly typified in the administration of the United States Government where hundreds of clerks in the accounting bureaus of the Treasury Department at Washington, under a false conception of revenue protection, unconsciously hamper the performance of upright and zealous officers and employees hundreds or thousands of miles away. The Bureau of Insular Affairs in the War Department is in advance of many others in employing in the Philippine Islands numerous traveling auditors. As a broad proposition, the inspector should seek necessary data of audit on the ground rather than have such data seek him in a distant office. It is predicted that the corporation of the future, and government is the largest of all corporations, will develop for its inspection service, including auditing, a corps of high-class men, composites of the inspecting officer of the army, the National bank examiner, and the traveling railroad auditor. At first, probably, such corps will be a set of more or less permanent specialists with the intuitive faculties highly trained. Since history repeats itself in organization as elsewhere, the gradual evolution in industry will be, as shown by the experience of the ages in armies and navies, to insist upon periodical rotation between the staff duties of inspection and the line functions of performance. The mistake made by many corporation officers is in believing that in all such matters the ultimate has been reached. Since all life is evolution, the wise man recognizes the fact that attainment of the ultimate must extinguish existence as surely as the variable of

mathematics would be wiped out if its limit could be reached.

Money itself, a measure of value, is but a symbol and a representative, and never performance itself. Because money brings position, power, and influence it is often confused with the result it produces. When in a more primitive state of society a few individuals were exploited at the expense of the many, the glamor of disproportionate individuality often obscured the fallacy of considering money or property as the primal cause of pre-eminence. When such unbalanced individualism yields to more rational collectivism, as reflected through the modern corporate organization of society, money and money accounts very properly lose in relative value.

The present social unrest flows not so much from dissatisfaction with the unequal distribution of wealth as from disappointment at the failure of its possessors to measure up to higher conceptions of stewardship. The people insist upon a regulation of wealth, and particularly upon a regulation of its uses through public-service corporations and other industrial enterprises. The struggle for adjustment now going on in the United States is but a manifestation of a larger cosmic tendency toward equality. The problem in the United States is intensified by reason of the fact that under our theory of government political power is more or less di-centralized. The tendency has been toward more and more political and governmental centralization in Washington. All the while financial power is becoming more highly centralized in New York. Much time will be needed for harmonizing these dissimilar conditions. In Europe, the political and the financial capitals are usually identical as seats of centralized power. It is interesting to con-

jecture the effect upon present conditions had a strong Federalist party been in power during the thirties, forties and fifties, a period of important railway and industrial development. The States Rights party then in power frowned down upon the notion of federal control of railways when their similarity to rivers and canals was mentioned. With so many disproportionate conditions it is lit-

tle wonder that corporations err on the side of unbalanced organization. Pioneers of thought may point the way, but consummation of scientific ideals in organization becomes fully practicable only when conditions are so acute that the necessity for remedies is self-evident, and the method of solution more or less self-suggesting to the masses of those concerned in the results.

(To be continued).

COST METHODS THAT GIVE THE EXECUTIVE CONTROL OF HIS BUSINESS

IV. THE ECONOMIC CONSIDERATION OF MATERIAL BY COSTS.

By Benj. A. Franklin

Mr. Franklin's purpose, as explained in introducing the first paper of the current series, is to exhibit the use and compilation of costs from the standpoint of the executive rather than that of the cost clerk. Beginning with the principles and elements that must be recognized to make a cost statement: a true and instant revelation of actual conditions, he proceeds to the character of the reports that must come periodically to the manager's desk, and then to the methods by which such data can be obtained and assembled. Actual details or devices of cost collecting are discussed only so far as they are important and interesting to the executive. His topics so far have been: "The Philosophy of Costs"; "The Place of the Trial Balance in the Cost System"; and "The Cost of the Salable Article."—THE EDITORS.

IT may be well, in considering material as the first of the three main elements of cost, to define what it means from the cost point of view. Material, as a cost term, includes only that which becomes a physical part of the finished article. Any other material necessary in the course of manufacture, which does not become a part of the finished article and cannot be charged to it as an integral portion, is not to be classed as material from the cost point of view, but falls under the head of expense, generally as a supply.

It is not to be implied by this explanation that any of that which is physically material, but is not so considered from the cost point of view, ought to be handled in manufacturing practice necessarily differently or with less care and consideration than

that which is material from both points of view, but that its use from the dollar and cents point of view does not bear the same relation to the final article cost. Unconsciously the executive handles it differently, even when he has no cost system nor any cost-system understanding.

Since this is really important from the standpoint of true economy, it may be well to illustrate it with the case of a tool manufacturer who manufactures all sorts of tools to make the work of mechanics easy and accurate, and in his advertisements advises the use by others. Having established his designs, he, of course, furnishes his men ample amounts of material from which to manufacture them. He has no hesitation in doing this because he figures that this material in a roundabout way, as it is

shaped into the salable article, is being converted into dollars in the bank. But he fails to furnish his men with adequate benches, modern lighting facilities, up-to-date tools which he may not manufacture. These latter are equally material from the purchasing agent's, and the concrete, point of view, but their connection with the return on the investment is not so direct and clear. One class of material gets all the thought and attention which the kind of business demands. Its application is direct. The other class of material gets frequently little or no study as to its use and value. Its application is indirect.

Cost consideration makes this point of view of directness and indirectness the dividing line, so that, in the classification of material as the first element of cost, only material of direct application as a part of the salable article becomes a matter of interest, all other material receiving attention as a part of the third element, expense.

Now material is the simplest of the cost elements in its application, and yet one of the most difficult and expensive to gather record of accurately.

Its simplicity lies in the fact of its concreteness, its visible use in manufacture, and the directness of its application to a particular finished article. It is always before the eye in definite form and with a predetermined and distinct destiny, and can be measured or weighed at any time.

Its difficulty and expense lie in the fact, that, despite this concreteness and visibility, it requires numerous and sometimes costly safeguards to get the quantities used and remaining on hand accurately recorded, and balancing with the facts of the case.

In this respect it entirely differs from the two other elements of cost, labor and expense, which lack con-

creteness and constant visibility, but can be absolutely accounted for to a penny in total used weekly and monthly, except in the part of expense where material enters as a supply.

In cost keeping there can be very little quarrel as to how to apply material in article costs. Reports of weighed and measured quantities are always chargeable directly to an order or article. The difficulty in devising methods to make sure that a correct report is made of all material used, is of two natures, physical and human. While it is true that the introduction of proper methods of receiving, storing, and issuing raw materials, and taking care of finished and semi-finished parts, demands an outlay of money in storerooms, clerical attendance, etc., it can be safely stated that such equipment invariably returns full value, in a reasonable time, in the savings made through minimum investment in supply of material to satisfy the demands of manufacture because of certainty of knowledge of supply on hand, promptness of delivery, and saving of waste. From the viewpoint of getting proper reports of material for costs, of course, such an equipment is invaluable in its assistance toward accuracy. It will largely solve the physical difficulty of gathering costs of material since it readily permits a definite record of its movements and disposal.

The human difficulty is also somewhat avoided by this equipment, but not entirely. There should be in every well conducted plant a definite watchfulness of the question of wastes of material, for it is here that the human difficulty arises. Operatives, through carelessness, accident, or of natural necessity, will spoil material, and in many cases

WASTE REPORT FOR UNIT PARTS—(FORM 7)

Item	Part M S				Part P Q				Part S T			
	No.	Rgh. lb.	Fin. lb.	Waste %	No.	Rgh. lb.	Fin. lb.	Waste %	No.	Rgh. lb.	Fin. lb.	Waste %
Standard	100	250	200	50 20	10	550	500	50 9	10	1,000	950	50 5
	500	1,380	1,010	370 27	20	1,203	1,005	198 12.1	1	105	96	9 8.5
	1,000	2,600	2,002	598 23	20	1,150	990	160 14	5	520	470	50 9.7
	800	2,050	1,600	450 22	10	560	502	58 10.3	2	195	190	5 2.6

WASTE REPORT. FOR MATERIAL IN MASS (FORM 8).

ARTICLE Y.

	Standard.			Lot 962.			Lot 1057.		
	Amts.	Waste	%	Amts.	Waste	%	Amts.	Waste	%
Material S.....	1,000			4,040			2,000		
T.....	338			1,347			666		
U.....	500			2,020			1,000		
V.....	3,117			12,591			6,234		
W.....	50			202			100		
Total Rgh. Wt.	5,000			20,200			10,000		
Product Sept. 1	4,750	250	5	18,988	1,212	6	9,186	820	8.2
2	4,700	50	1	18,798	190	1.	9,130	50	.5
3	4,600	100	2	18,438	360	1.8	8,830	300	3
4	4,500	100	2	17,776	662	3.5	8,470	360	1.8
Total Waste....		500	10		2,424	12.3		1,530	13.5

even dispose of the waste surreptitiously.

There are three factories in mind where discovery was made that this complete loss of material amounted to many thousands of dollars a year.

It must be remembered that the material cost of an article is not obtained by dividing the total cost of material issued on the order by the number of units started with, but by the number of units finished and delivered, which, on account of waste, most often yields a very different result, and this fact necessitates a careful record of the progress of material and the wastes made during its progress. But a point of even greater value here is that all the wastes should be thoroughly known, so that they may be kept to a minimum.

Every plant has enormous wastes. Some of these are difficult or apparently impossible to eliminate. Some naturally take place in the right attempt to reach reasonable and high standards of quality. Yet all should be carefully watched and fought against.

The waste of material is one of the great crimes of the ages. We suffer from this fact today, and our descendents will suffer still more. We eat too much. We are careless in the use and preservation of all kinds of material.

This waste is one of the largest of the reasons of the high cost of living. And there seems to be no great movement in the world to fight this waste, except in a few cases, because the tendency to waste is too deeply inbred, and because we have few good statistics, or standards, as yet to show the volume and percentage of it. But every good executive should furnish himself with the statistics in his factory, and should use his cost system to fight this tendency.

There are in all factories several kinds of waste. There is of course most prominently that which naturally occurs between the raw material and the finished article. It is principally of four different kinds and in all kinds of work it can be reduced by very careful study.

First, the design may be altered, for it is true that many articles are manufactured from designs not scientifically worked out. In making this alteration, of course, it would be folly to do it until after all questions of quality, strength, shape, and durability and the necessary factors of safety, had been properly considered. This waste through wrong design cannot be shown an executive by any tables. He must simply recognize the necessities and values of the case and engage the proper abilities, if his staff does not include them, to accomplish this economy. It is of course as false an economy to skimp the material in the finished article, and thus to build a reputation which will eventually decrease sales, as it is to make the product too heavy by a guess and a determination to be on the safe side. Frequently experiment may be necessary in the final determination. In a staple article to be continuously produced, the cost of the experiments would generally be small in comparison with the value of results. Where this waste occurs it involves in time the loss of a very large amount of money on account of its constant repetition.

A second form of waste of material comes through improper purchasing, natural shrinkage, changes in design at inopportune time, leaving on hand specially shaped or sized material, or through those errors in judgment or calculation which leave on hand useless or obsolete material. A mistake that the executive generally makes in the matter of this ma-

PART N 6.

SPOILED WORK. FOR UNIT PARTS (FORM 9).

Order or Lot	No Start'd	No Good	Opera-tion	Man	Mch	Spoiled	No Good	Opera-tion	Man	Mch	Spoiled
Standard	100	106	K	26	7	2	98	L	95	17	0
99	500	500	..	26	..	5	495	L	..	..	0
103	100	100	..	26	..	3	97	L	98	18	1
207	1,000	1,000	..	96	9	50	950	L	..	18	1

DR. MATERIAL JOURNAL CR. (FORM 10).

Work in Process—Classes				Date	Item	Order No.	Raw Materials on Hand				
D	C	B	A				1	2	3	4	5
		92.18			Material XXX	56			92.18		
		27.00			" XX	56		27.00			
		5.52			" X	56	5.52				
			28.12		" X	79				28.12	
		3.18			" XX	86		3.18			
	49.20				" XXXX	103					49.20
49.20	3.18	124.70	28.12		Totals.....		5.52	30.18	92.18	28.12	49.20

terial is that he lets it lie around indefinitely in the hope that some happy day may dawn when a use can be found for it. It is generally, however, the wisest thing to dispose of such material at least loss, and to charge the loss to general expense. A periodical survey of the list of material on hand will discover this waste.

A third and principal point of waste occurrence lies in the natural reduction of the original raw material in its progress toward the finished article. Many executives, considering this waste natural, pay little attention to its volume. But there lies here, as observation has again and again proven, large opportunity for economy.

A fourth method of waste occurs in the spoiling or loss of units of production in progress, through carelessness, the development of unexpected defects, processes gone wrong, or by the many difficulties that beset the manufacturer of the perfect article.

It is a simple and natural corollary of a right cost system that proper records of waste should be gathered and shown. Forms 7, 8, and 9 indicate styles of reports that every executive should have regularly laid before him. These forms are shown on pages 50 and 52.

It is not possible to make a standard form of waste report that will fit every business. Each business must display in its own sequence of operations where wastes occur. In a business like the metal trades in which the finished article comes out of a purchased shape, or from a commercial form suited to its production, the style of Form 7 may be used to show waste in progress of manufacture, but it may be varied all the way from showing waste only between raw material and finished article, to

showing it at each operation, or by departments.

In a business where the materials are mixed in mass and change their character as they merge together, the style of Form 8 may be used for the same purpose, and again with such variations as from raw material direct, to finished article, or by departments, or operations.

Form 9 illustrates a possible method of waste record of spoiled work where integral parts are started with. Form 8 may be elaborated for the same purpose where the production is in mass. Such analyses if followed closely will always develop large economies. But it must be understood that it is generally not enough to know merely that there is a definite loss. The reasons therefor must be classified and studied in order that remedies may be had.

These forms are shown merely by way of example. No intelligent and economically studious executive will be long in discovering the practical way for his business. By the practical way is not meant, however, the easiest way, but the way that brings out best where the wastes occur.

It is not good logic to argue, as do some executives, that it is needless to keep track of the waste where it is of no value. It must not be forgotten that waste, valueless as such, costs money when it was purchased as raw material and would be worth money if not wasted. Records thus kept of waste will eventually permit the creation of proper standards of maximum and minimum by which to work.

It may not be inappropriate to point out here, that, once right standards are fixed, the intense co-operation of operatives may be obtained in reducing actual waste to them, by a form of bonus, just as quantity per hour is increased. The method has

been explained in a previous article in THE ENGINEERING MAGAZINE under the title "Quality Piecework."

A great many cases of waste study, and marvelous savings therethrough, might be given, and they would undoubtedly make this article more interesting; but the thinking executive will generally have no difficulty in calling to mind some instances in his own experience, and even a slight one should urge him to widen this experience to the utmost, for any investigation in this direction always pays large dividends.

It is often necessary in the study of waste reduction to collect the waste physically separately as to classes or articles as well as to possess its statistics. There is in mind one plant, making many small parts, which established a "bone-yard," where weekly are displayed all spoiled parts with a tag showing how, where, and by whom spoiled, and to this are first led the foremen and they in turn lead the culprits. The result is very satisfactory. The study of waste is a vital element in factory economy.

Of course in the proper gathering of material cost, the purchasing department plays a large part. It must furnish simple but complete records of raw-material unit prices. Now it is the province of a purchasing department to get the greatest value for the least money. But it is very true that the cheapest materials per unit of finished product are not necessarily the cheapest materials per unit of raw material. The purchasing department, then, should keep in touch with the waste reports, because from them it may well discover the most economical material to buy. Of course, into this consideration also comes the question of the quality of the finished article.

Since it seems not to be a very

well known method, though a very simple one, of connecting the material reports with the bookkeeping accounts, as well as with the order costs, Form 10, a material journal, is shown here. No lengthy explanation will be necessary. As is apparent, the material, as reported, is credited to its proper raw material account, and debited to the class of work in which it is used under the head of "Cost of work in process." The order number is shown, so that for order costs, perpetual inventory of raw materials and bookkeeping purposes leading to the complete trial balance, this material journal is effective.

In the perpetual inventories of material in dollars and cents which appear under the head of "Raw Materials on Hand" in the trial balance, lie the crucial tests for accuracy of the whole cost system, for, as will be seen later, the other elements of cost, labor and expense, are readily proven weekly and monthly as to their accuracy in the total cost.

It will be observed that these figures of Raw Material on Hand are obtained by starting with an actual inventory, adding monthly purchases, and deducting monthly the amount of material reported used. Making the fair assumption that the inventory to start with has been taken carefully and accurately, it will be recognized that the only source of error lies in the reports of used material. Now despite all precautions, it is with difficulty that the dollars and cents total of material used monthly is accurately obtained. Carelessness in measure and weight, surreptitious extraction of material to replace spoiled work, occasional theft, unavoidable wastes by shrinkage, etc., changing prices on different lots of the same material, make this task one of difficulty to which

the executive should give some attention. He will in the end be able to remedy them.

Of course proper means of storing and issuing materials present the greatest remedy. Checks by careful observation of the costs, and at the end of different lots as to balancing of amount purchased and amount reported used, will show other delinquencies. The addition of definite percentages based on careful experience and observation will correct many shortages due to material shrinkages, for it is well known that many substances, such as coke for example, will weigh into a car an appreciable percent heavier than it will weigh out.

To help such a situation out, materials should be arranged and kept track of in the book-keeping by classes, and if narrowed down to reasonably small ones, as experience dictates, actual inventories and checks as particular lots disappear, will in time bring accuracy of stock actually on hand with book values, so that the latter may be depended upon, and total accuracy assured.

And this is very definitely a matter in which the executive should interest himself, because it involves definite losses through wastes, and its proper solution invariably leads to larger profit.

The application of our philosophy of costs will not at first seem so plain in relation to this subject of material, yet it is extremely important.

In accuracy, material cost should be absolute because of its direct application. Nevertheless there arise many cases, as indicated, where in practice this does not prove to be true, and we are here forced back upon practical accuracy or accuracy of total cost. For when material is discovered to have disappeared with no knowledge as to what order or

article it is chargeable to, or to become obsolete, then we must fall back in actual practice upon some practical, even if not theoretically right, way of getting it into costs, such as adding it as a percent to the material costs of those articles which use the disappearing material, or putting it into expense, where it will be divided over total production, as circumstances may dictate.

There are those who advise that the cost of work spoiled in process should be a charge, not against the particular order or article, but against the total work through additions to expense; but this is a very arguable matter, and it would seem that more is to be gained in the long run by letting each class of work stand for its own misfortune.

Imagination to visualize the facts of use and waste of material from the figures, and practical instinct to detect the weakness and the remedy are of course essential.

In fact, imagination in the consideration of material helps to simplify and beautify the whole manufacturing proposition. It can lure up the picture of the raw material, its course through the cohort of workers, changing its shape and form, sloughing its natural wastes as it is touched into a thing of use and profit, while practical instinct follows it to see that the purchase is of best quality and price, and that it progresses with minimum waste and effort. It can bring forward constantly the sad consideration that since raw material in most factories is merely the finished product of previous labor, its waste is not merely the waste of the material itself, but the setting at nought of the earnest work of many hands that have brought it thus far on its way to final usefulness. The cost figures furnish ample basis with right stan-

dards, for the practical exercise of these elements of the philosophy of cost.

Standards, especially of waste, and of stock on hand, are, in the matter of material, peculiarly valuable and necessary. Waste of material in factories is so large, so usual, and so essential, that, without carefully worked out and insisted upon standards, all concerned are liable either to become satisfied and indifferent, classing the waste made, whatever it may be, as a necessary corollary of manufacture, or, if the manufacturing conscience of the executive be tender and his horror of waste great, the attempt to reach an impractical minimum becomes more expensive than the waste.

No one will dispute the necessity of comparison. Progress in any direction fails to show without it.

With such a mass of figures as the question of material and waste presents in factories, where attempt is made to follow waste carefully, most value is lost without proper arrangement, for the weakness must be quickly seen.

Periodicity becomes vital in its necessity for promptness. Wastes should be known and presented as soon as possible after their occurrence. Where the work is large a daily report is advisable. Where articles are small, or the product is in mass, the knowledge can generally and most practically be known as the lot passes completely each operation.

There is no element more vitally valuable than co-operation of the organization in the matter of care of material, and consideration and watchfulness of waste. There is no reason why such records should not be open to everyone concerned, and indeed great attention should be paid to impressing these figures upon

them. Everyone concerned in manufacture works better with a goal, an aim, a standard toward which to strive.

To recapitulate then, the cost consideration of material leads to economies through:

The proper purchase of material.

The proper care and issue of material, and studied corrections at points where errors are liable to occur.

Scientific design of product.

Care that material shall not become obsolete.

Watchfulness of waste of material between raw material and finished product.

Watchfulness of waste made by spoiling units of production.

Much attention has been given, in discussions of economies of management, to the element of labor. A proper conception of the element of material, however, as the basis of all labor, as the element, springing only from natural sources, which labor shapes into forms of use and beauty, the cheapness and plentifulness of which make for the happiness of the whole, and the waste of which is to abuse instead of to bless nature's bounty and the work of our fellow-man—if this conception could be universally held up, highest speed of production and maximum prevention of waste would not be ideals still so far from accomplishment. But taking the situation as it is, the intelligent executive will supply himself with the best safeguards in the handling of his materials, and, with set standards, use his material costs and records of wastes, proven and in ample detail, to keep himself and his organization working steadily toward the best results.



FIG. 1. FUSELAGE OF THE MORANE MONOPLANE. SEE PAGE 64

THE ENGINEER'S RESPONSIBILITY FOR THE AIR CRAFT OF THE FUTURE

By Capt. Horace B. Wild

Captain Wild is a skilful aviator and balloonist, licensed pilot of the Federation Aeronautique Internationale, and he expresses his individual opinions after personal study of the exhibits shown at the Aviation Salon, in Paris. His attention in this article is directed solely to engineering questions concerning motors. A following paper will take up mechanical and structural details of aeroplanes.—THE EDITORS.

THE future and progress of the aeroplane and aviation are in the hands of the engineer, and not until the engineer takes hold and applies his schooling in construction and design and practical way of obtaining results, will the aeroplane be made use of generally. The comparatively crude and unreliable motor that we have at our disposal at the present time, is no doubt the cause of many of the fatalities and accidents befalling the aeroplane, and these are almost entirely responsible for the late set-back from which aviation has only just begun to recover.

The American engineer is no doubt capable of designing and building a motor that will be thoroughly reliable and meet the requirements necessary to make the aeroplane of great commercial value.

The enormous amount of money which has been expended in developing a gasoline motor such as is used

in automobiles today ought to be an incentive to the designer to forbear spending valuable time and capital on freak motors. Year after year the designers and engineers of gasoline motors have worked diligently, until the automobile engine is now almost perfection, and is what might be termed thoroughly reliable. Can we not apply this same engine to the aeroplane, and is it not possible to profit by the experience of the automobile-engine manufacturer? When will the engineers who have developed the automobile engine turn their attention to the aeroplane motor?

If one will look over the accessories attached to the aero engines of today, it will be noted that it is stripped clean of everything possible which would add head resistance or weight. Very few aero engines have fiber tubes for conveying the high-tension leads from the spark plug to the magneto, which is very necessary to

stop leakage and prevent the lead from coming in contact with the hot cylinder, also to keep it from breaking off at either of its connections. Every first-class automobile built in the last five years has this attachment to its engine, and also facilities for water circulation around the jacket of the carburetter, which would surely eliminate the trouble of freezing at high altitude. These details, however, had been absolutely

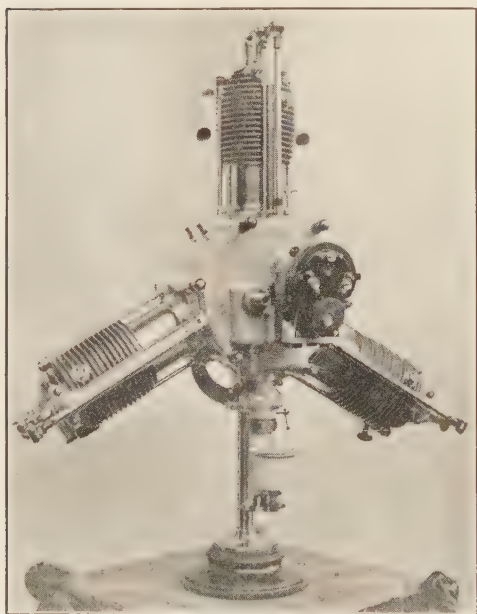


FIG. 2. V. TYPE B. ANZANI. PAGE 64

ignored in the aero motor. The designer of the aero engine is too anxious to eliminate what he deems unnecessary parts, in order to reduce the weight of the engine, and in doing so, he often takes away the parts which help to strengthen the duration and reliability of the motor.

AIR-COOLING VERSUS WATER

Considering the aeroplane engine generally, let us sum up the relative advantages of the air and water cooling, as we meet them. The advantages on the side of air cooling are: (1) Greater simplicity, owing

to the absence of water, with its liability to freeze, and the lack of radiator and pump. (2) Less weight. (3) Smaller manufacturing costs.

Its disadvantages are: (1) Less horse-power per cylinder of given capacity, and probably lower thermal efficiency, since it is impossible to employ as high a compression as in the case of a water-cooled motor. (2) Considerably greater trouble in keeping the valves properly tight, as the high temperature in which they work is unfavourable to them. (3) The large head resistance when such engines are placed in the position necessary to ensure adequate cooling. (4) The difficulties of lubricating an engine at a high temperature, necessitating generally a wasteful expenditure of very expensive oil, which quickly forms a thick deposit on the top of the piston and in other places.

The advantages of water-cooling are: (1) More power is obtained per unit of cylinder capacity. (2) Valves give, or should give, practically, no trouble. (3) The radiators used for cooling can be so arranged as to offer very little head resistance. (4) The lubrication problem is much simplified.

The disadvantages are: (1) The complications of water cooling with its numerous joints and liability to freezing up. (2) Greater manufacturing cost. (3) Greater weight.

One point, however, deserves passing mention, namely that of a stationary engine which always had considerable pull over its rival in the matter of price per brake horse-power, other things such as workmanship and material being equal. In summing up the advantages between two different types, the water-cooled engine has a larger percentage of value where power, duration and economy in gas and oil are taken into consideration.

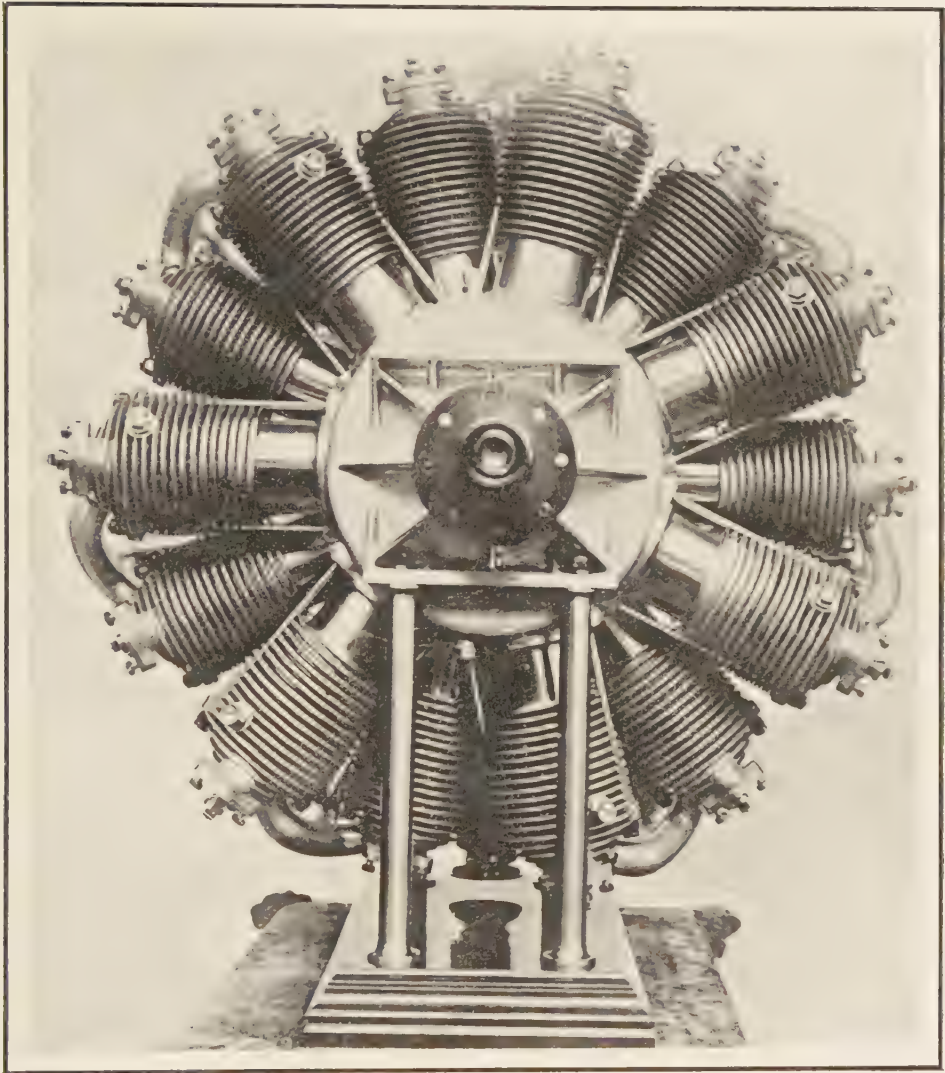


FIG. 3. ANZANI FOURTEEN-CYLINDER. SEE PAGE 65

Another point in favor of the water-cooled engine is the low head resistance and the fact that the valves will give much less trouble and the motor will give its maximum power for a longer time without attention.

There are two types of air-cooled engines that should be considered separately. One is the rotating cylinder, which has the disadvantage of causing a huge head resistance and is most extravagant in the enormous quantity of oil it consumes for the small amount of power to be derived

therefrom. The other type is the air-cooled motor which is cooled by a fan. This type probably succeeds in keeping the cylinder temperature lower than a similar motor without a fan or propeller, but its cylinder conditions are not so good as those of the water-cooled motor and it utilizes much more power in driving the extra fan where the propeller is not situated to assist in the cooling.

Undoubtedly there will be a great demand for higher-speed aeroplanes which will sooner or later eliminate

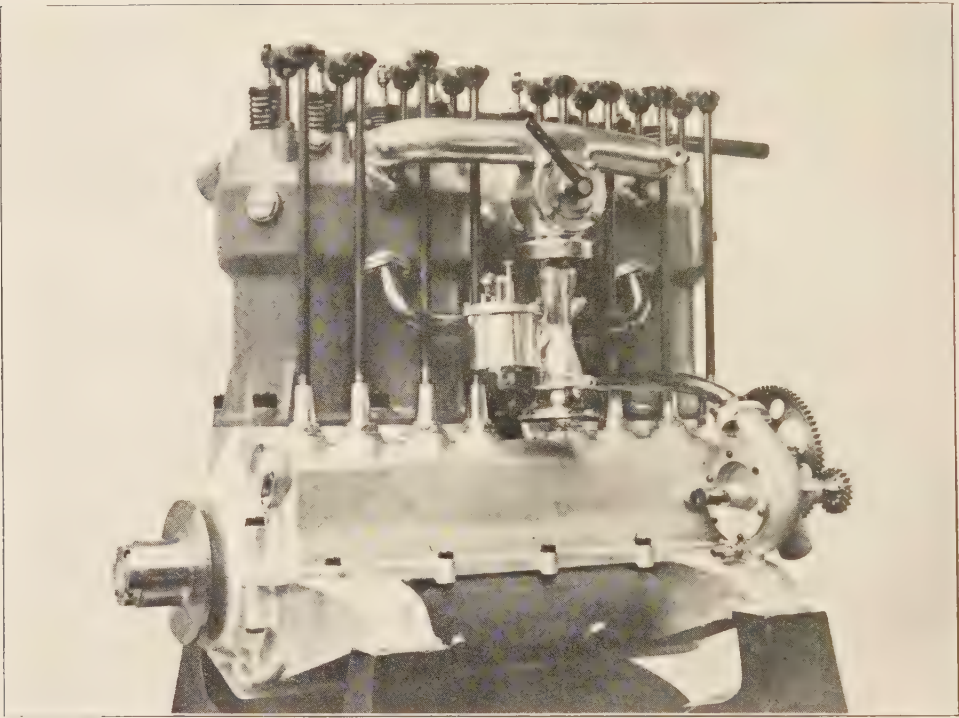


FIG. 4. AVIATIC FOUR-CYLINDER. SEE PAGE 65

the rotary motor, unless one is developed that can be efficiently cooled when placed inside the fuselage, as in the new Morane all-steel monoplane. In this type the water-cooled motor will surely prove very satisfactory in duration and reliability.

Few engine designers seem to appreciate the importance of eliminating the least tendency toward variations of angular velocity in the torque if the engine is required to drive a propeller. The effect of continually accelerating and retarding a propeller is most detrimental to its efficiency. The difficulty can best be overcome by increasing the number of cylinders until their impulses overlap. The four-cylinder engine, in which the torque drops to zero twice during every revolution, is unsuitable for aeroplane work, except in very small sizes, and in all cases it turns a propeller very much better when fitted with a suitable fly-

wheel, owing to the inertia of the flywheel smoothing out the uneven torque. A further reason for increasing the number of cylinders is that it is most undesirable to use very large cylinders in an aeroplane. It is impossible to balance the recoil of an explosion in the cylinders of an engine of standard design. The heavy recoils given by large cylinders necessitate much stronger structures to withstand them, which means additional weight. Not more than 12 horse power should be used per cylinder at most for motors up to 100 horse power, and in fact a lower horse power per cylinder than this would be advantageous.

In front elevation a water-cooled aero engine should be as compact as possible, and the crank case should be fitted with a nose long enough to enable the designer of the aeroplane to round off his fuselage nicely in front so as to reduce head resistance.

There should be a sump in the crank case holding enough oil for a six-hour run, and the pump should be arranged in the sump in such a manner that it is always drowned in oil. All oil pipes should be cast in the crank case walls, or placed internally, and care should be taken that no oil leaks out anywhere, so that the engine keeps clean. All the running parts should be automatically lubricated under pressure, and it would be well to fit an indicator in some suitable spot, so that the aviator can assure himself that the oil is circulating. The crank-shaft should be arranged to take a propeller without having to make special fittings; propeller makers could state exactly what is required here.

The carburetter should be fitted with an appliance ensuring adequate warming under all conditions, and the carburetter should be fitted as low as possible to enable petrol to be fed by gravity. Some appliance should be fitted to take the leads from the magneto to the plugs, so as to prevent them from hanging in festoons all over the engine, and one of the new dual magnetos should be used with two plugs in each cylinder, so that if one plug gives out the cylinder in question does not cease firing. The engine should not be fitted with open exhaust ports; these cause a considerable amount of noise, waste large quantities of oil, and are necessary only in cases where the valve design is inferior.

All aero engines should be fitted with exhaust-valve lifters for stopping, and high-power types should have a half-compression device to

facilitate starting. A short shaft should be allowed to project for an inch or two in some suitable position, so that a speed indicator or similar instrument may be fitted if desired. If the valves are to be placed in pockets, care should be taken to ensure adequate contact between these pockets and the water jackets so that the valve seats and valves have a chance of keeping cool. The ex-

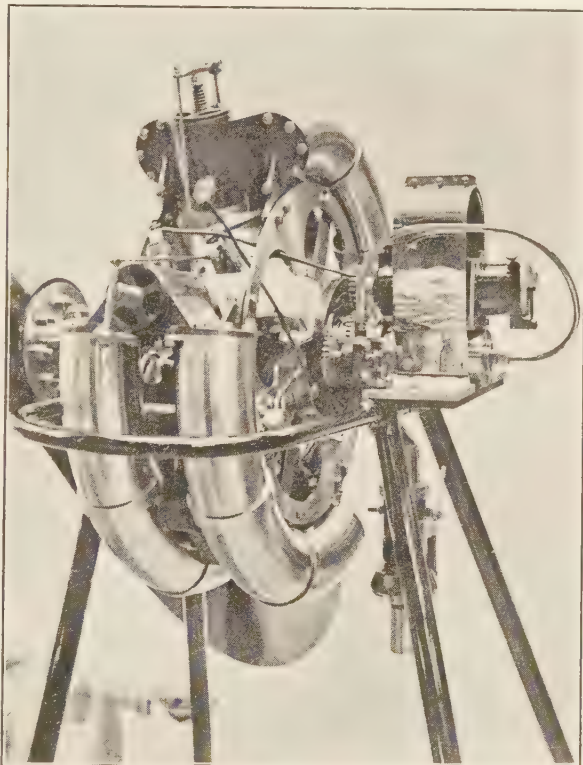


FIG. 5. BECK ENGINE. SEE PAGE 60

haust ports should also be arranged so that the pipes can be fitted to them to conduct away the exhaust gases. The lugs for the holding down bolts should be placed to allow the engine bearers to run straight through from end to end of the motor without getting in the way of the magneto, water pump, or other fitment, and they should, of course, be drilled parallel with the crankshaft.

Engine builders generally would

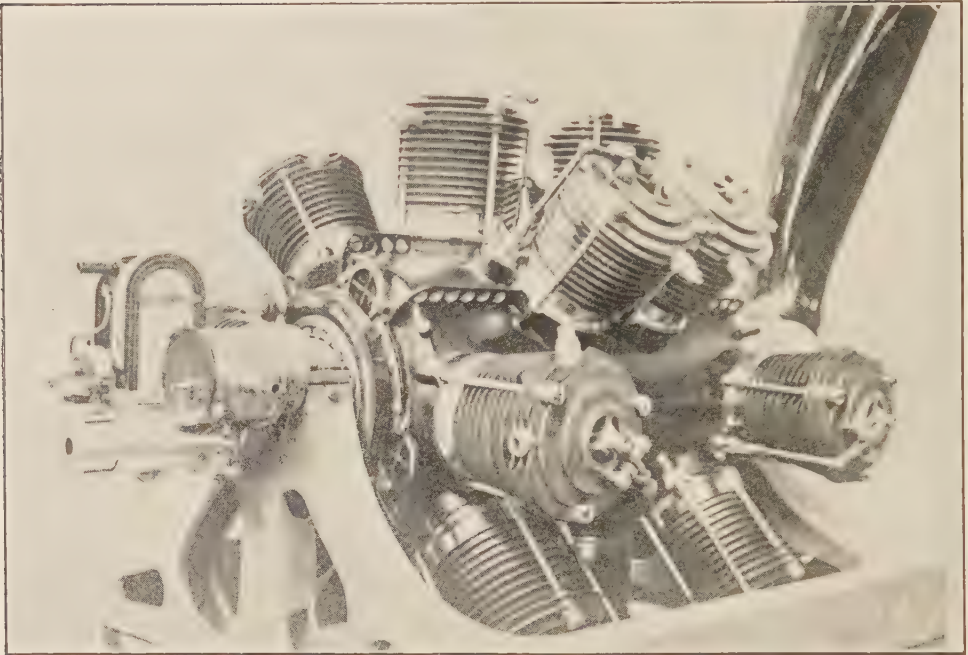


FIG. 6 BURLAT SIXTEEN-CYLINDER. SEE PAGE 67

also do well to visit aviation grounds more frequently, and to take more interest in the engines which have left their hands. They would then better appreciate the fact that an engine carefully tuned up in their works cannot be put straight into an

aeroplane and run right away without adjustments; they would pick up a vast amount of practical experience and one would hear less of the expression from the so-called aero-engine manufacturer, that the motor is perfect and that absolutely nothing

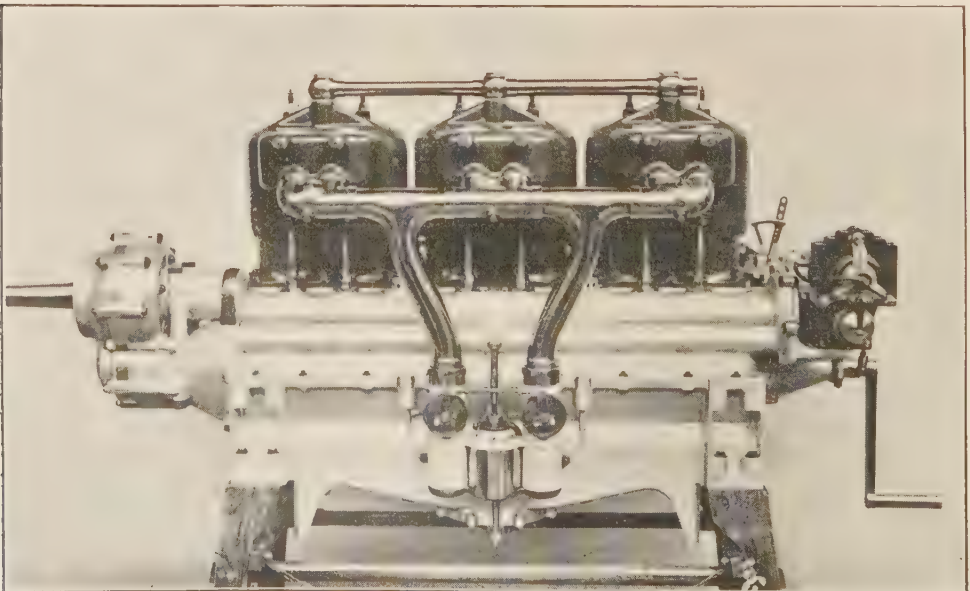


FIG. 7. CHEUN SIX-CYLINDER. SEE PAGE 67

can get out of order, and that it is bound to work perfectly as long as it is fed with gasoline and oil; though in many cases the aviator does not leave the engine alone when it is working right, but tinkers with the different adjustments until they are all out of harmony with one another and places the blame where it does not belong.

tracting more attention for aeronautic purposes. There were about six stationary engines to one rotary engine exhibited. One might say that the type of engine has developed which can be described as quasi-rotating. These two types represent, both of them, a mean between the theoretically perfect and the practically expedient. Stationary engines

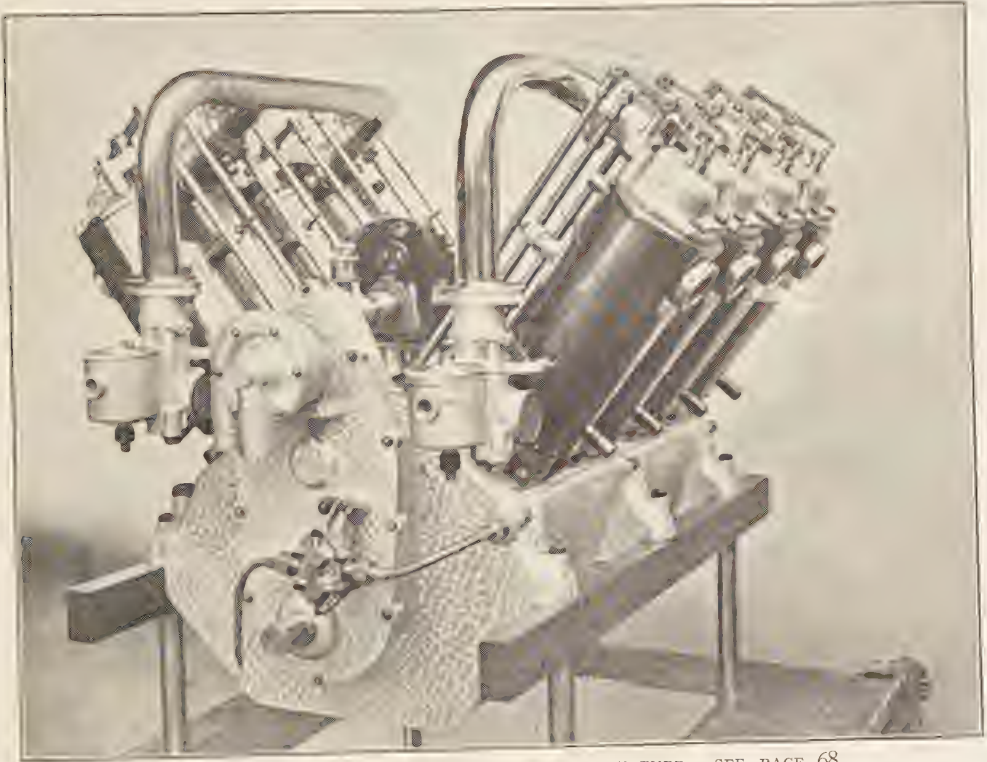


FIG. 8. DANSETTE-GILLET EIGHT-CYLINDER V TYPE. SEE PAGE 68

The demand for a reliable motor is still prominent. In looking over the Paris aviation show held in the Grand Palais at the close of last year, one could not fail to notice the large number of aeroplane motors exhibited, and the widely divergent types in which these motors are classified.

In the past, the rotary engine of the Gnome type has been universally favored for the aeroplane, although at this time the water-cooled engine of the automobile type of motor seems to be gaining ground and at-

sacrifice torque to gain power, while the rotary engine sacrifices power to gain a high torque. Both classes have their firm believers, and it is difficult to say which is the better system from an aeronautic standpoint of view.

A great many designers work out an engine for aeronautic purposes, and their one aim is to make it as light in weight, pounds per horse power delivered, as possible. On paper others show certain mechanical advantages; but whether these can

be made good in practice, remains to be seen.

The engine manufacturer who will knuckle down and design and construct a really satisfactory motor now would have almost the whole trade to himself; and the aeronautic engine will be in great demand, and the trade will be well worth having. He will also receive the congratulations of the whole aeroplane industry, and have the satisfaction of knowing that he has made the aeroplane infinitely more reliable than it was before.

MORANE MONOPLANE

Figure 1 is a view of the new Morane monoplane fuselage, constructed entirely of steel, which has a beautiful stream line. The head resistance of this machine may be greatly reduced by installing the water-cooled engine instead of the rotating cylinder. The motor is installed just inside of the front port-holes, and as yet the machine has not had sufficient tests to enable one to speak intelligently on the possibility of satisfactory results with an air-cooled engine.

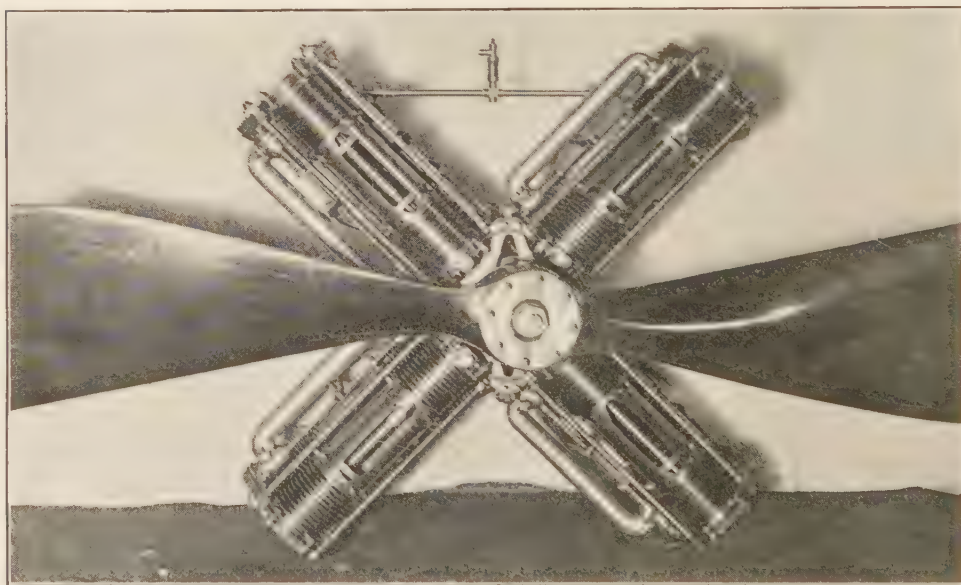


FIG. 9. FAVATA CROSS TYPE. SEE PAGE 68

The accompanying illustrations and descriptions will give some idea of the development of the aerial engine in Europe. Also a description is given of the two leading American engines, air and water-cooled, and the names of other manufacturers engaged in trying to perfect an engine that will stand up under the various requirements of the flying machine. Most of the American-made engines are designed and built too light, but we may expect to see some great improvements in the domestic engine the coming year.

Y. TYPE B. ANZANI

Figure 2 is a Y. Type B. Anzani, used in the small Bleriot monoplane. In this the three cylinders are set at 120 degrees with one another; they are fired at even intervals of 240 degrees, and the torque is therefore the very best possible for three-cylinder motors. The crank shaft is single-throw, one of the big ends being a master to which the others are articulated in a patented manner. There is no flywheel either internal or external, and the crank shaft runs on ball bearings. The arrangement of

valves is the same as in the preceding type, except that the engine can be supplied with mechanically operated inlets if desired. Another difference from the original three-cylinder Anzani is that the cylinders are offset considerably to the crankshaft.

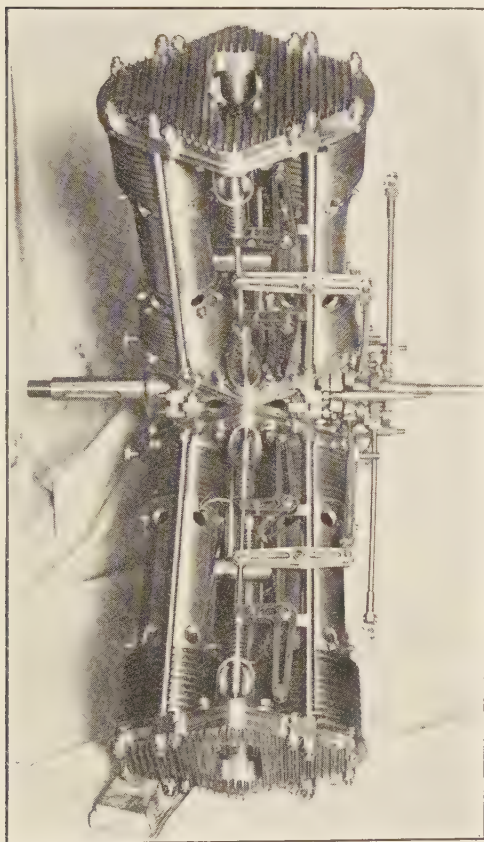


FIG. 10. FAVATA CROSS TYPE. PAGE 68

ANZANI FOURTEEN-CYLINDER

Figure 3 is Radial Type D. 130 horse power, and it has 14 cylinders grouped in exactly the same way as the 100 horse-power Gnome. In other respects it follows exactly the same lines as the smaller types. The bore and stroke are respectively 90 and 120 millimetres, and the weight 330 pounds. Head resistance, 9.7.

AVIATIC FOUR-CYLINDER

Figure 4. This engine is made in three powers, 70 horse power, 100

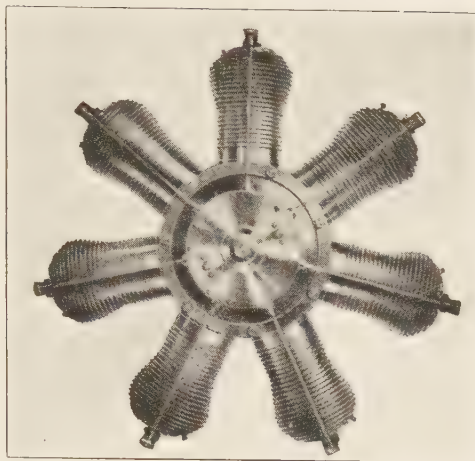


FIG. 11. GNOME. PAGE 69

horse power and 150 horse power. In each case there are four cylinders, the dimensions being respectively 124 by 130 millimetres, 140 by 140 millimetres, and 155 by 165 millimetres. The characteristics of all these engines are the same, and include cylinders cast *en bloc* and offset, overhead valves, and cast-in induction ports. A feature which gives the aviatric engines an individuality of their own is the extreme shallowness of the water jackets, which are practically no more than water-cooled heads. The weights are respectively 253 pounds, 330 pounds and 350 pounds.



FIG. 12. HELIUM STAR. PAGE 69

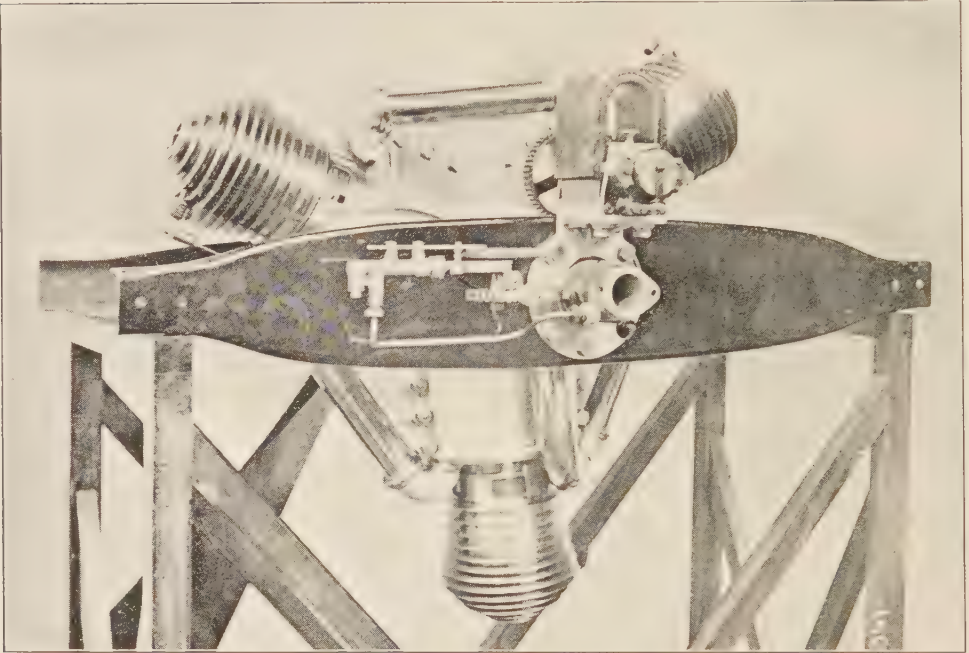


FIG. 13. 17-AVIATOR THREE-CYLINDER ROTARY. SEE PAGE 70

BECK ENGINE

Figure 5. An ingenious air-cooled engine is the Beck. In this case the cylinders, instead of being straight, form sections of a hollow ring, which is made by fixing together two semi-circularly dished flanges. In the ac-

tual Beck engine there are two pairs of pistons running in two separate annular sets of cylinders, and therefore four crankshaft impulses take place per revolution. The dimensions and weights are as follows: 35 horse-power, bore and stroke 80 mil-

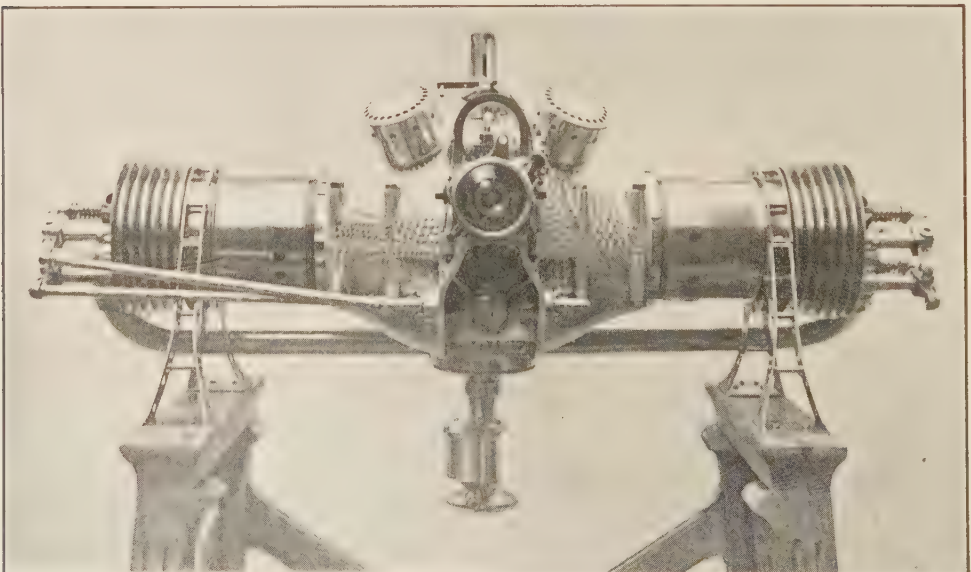


FIG. 14. NIEUPORT TWO-CYLINDER OPPOSED. SEE PAGE 70

limetres by 130 millimetres, weight 154 pounds; 50 horse-power, bore and stroke 110 millimetres by 130 millimetres, weight 180 pounds; 75 horse-power, bore and stroke 110 millimetres by 130 millimetres, weight 190 pounds. Figure of head resistance, 13.

ton as in the Gnome, and the exhaust valve is situated centrally in the head. It will be perceived that, compared with an engine of the Gnome type, the Burlat has the disadvantage that the flywheel effect of the revolving mass of cylinders is not so great, whilst there is a second practical dis-

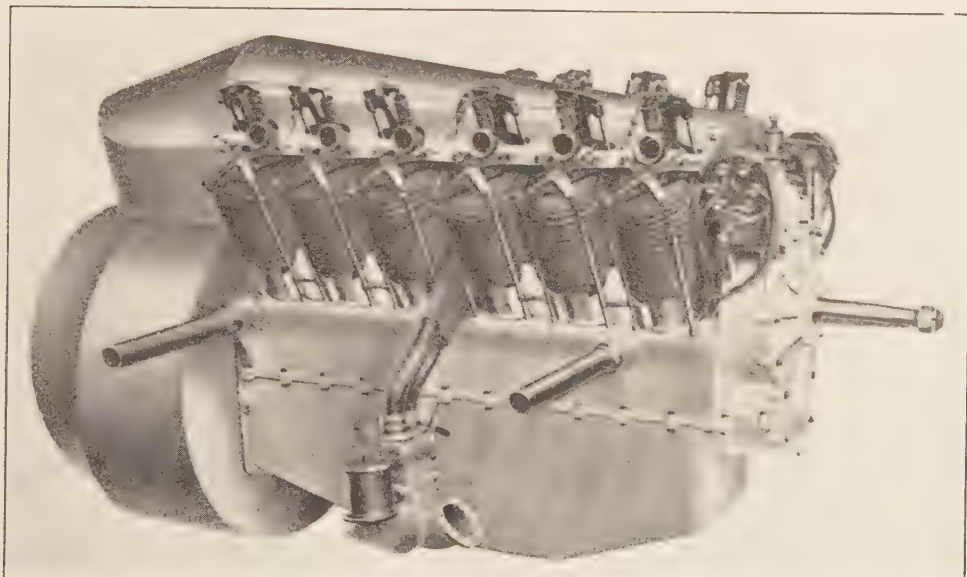


FIG. 15. RENAULT V. TYPE. TWELVE-CYLINDER, 90 HORSE-POWER

BURLAT SIXTEEN-CYLINDER

Figure 6. One of the most interesting motors in the show was the Burlat, the principle of which is extremely ingenious and simple, in spite of which fact a very small proportion of the people who have heard of this engine have taken the trouble to ascertain its mode of working. It must be admitted, however, that this is not at first very easy to understand. The engine is made in three powers, 40, 70 and 140 horse power, the two smaller engines having eight cylinders and the larger sixteen. The dimensions are respectively 95 by 120 millimetres and 120 by 120 millimetres. The crankshaft makes 1,800 turns per minute, while the cylinders make 900. The cylinders are of cast-iron, each being held down by four bolts. The inlet valve is in the pis-

advantage that, in spite of the fact that the number of wearing parts is somewhat reduced, the machining has to be done with absolutely perfect accuracy. The weights of the above mentioned models are respectively 190, 265 and 500 pounds and the figures of head resistance 9, 9.5 and 10.2.

CHEUN SIX-CYLINDER

Figure 7. This is a very highly specialised engine of the car vertical type, and is made in four sizes as follows: 50 horse-power four cylinders, 110 by 190 millimetres, weight 250 pounds; 75 horse-power six cylinders, 110 by 190 millimetres, weight 370 pounds; 120 horse-power four cylinders, 150 by 200 millimetre, weight 400 pounds; 180 horse-power six cylinders, 150 by 200 millimetres, weight 500 pounds. In de-

sign and workmanship these engines, which have been recently performing with considerable success, represent a very high standard. The cylinders are cast in pairs, and have their valves on opposite sides. The inlet leads are cast in the sides of the head, and are united by two short lengths of inlet pipe communicating with a double carburetter, a method of distribution that should do much to overcome the slight carburation trouble which is known to most six-cylinder engines. The 75 horse-power motor, which may be taken as the prevailing type, is made both for direct and reduction drives, being fitted with an exceedingly neat reduction gear supported in an aluminum housing on the crank case.

DANSETTE-GILLET EIGHT-CYLINDER V TYPE

Figure 8. A water-cooled car type engine on fairly standard lines, except that it has a combined and

concentric exhaust and inlet valve arrangement. It is made in the following sizes: 35 horse-power four cylinders, 98 millimetres by 125 millimetres, weight 200 pounds; 50 horse-power four cylinders, 105 by 160 millimetres, weight 240 pounds; 75 horse-power four cylinders, 130 millimetres by 160 millimetres, weight 330 pounds; 120 horse-power eight cylinders, V, 114 millimetres by 160 millimetres, weight 400 pounds.

FAVATA CROSS TYPE

Figures 9 and 10. This engine is of the stationary radial type, each cylinder being double-acting and working on a four-stroke cycle. There are two opposite pistons in each cylinder, united by a cross-head carrying outside through a slot in the cylinder an external connecting rod, round which a casing is provided. A great point is made of the fact that the four-cylinder en-

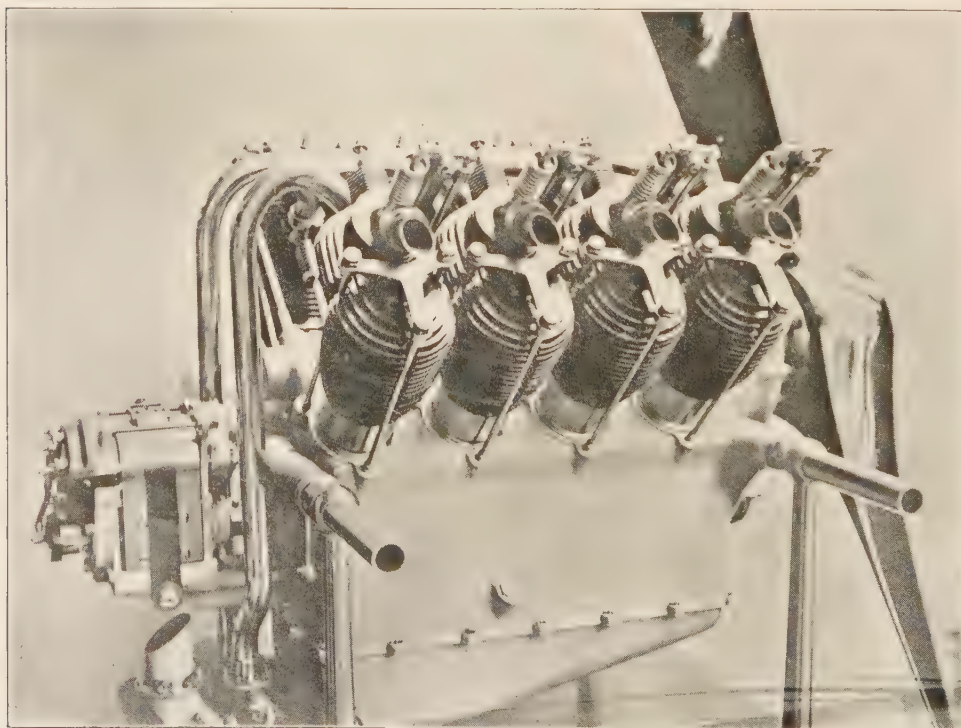


FIG. 10. RENAULT V-TYPE, EIGHT-CYLINDER, 35 HORSE-POWER. SEE PAGE 71

gine is a complete unit, to which a second unit or a third can be built, one behind the other. These units can be arranged so that one opposite pair of cylinders can be worked while the other remains idle, as each is complete in itself, and has its own valve gear, magneto, etc. The single four-cylinder unit is rated at 45 horse power and weighs 110 pounds, the dimensions being 110 by 120 millimetres. Figure of head resistance, 5.2.

GNOME ENGINE

Figure 11. The Gnome engines have no alterations of any note in the design and construction of that famous type, and are made in four models, i.e.: 50 horse-power and 70 horse-power, seven cylinders, with cylinder dimensions respectively of 110 by 120 millimetres and 130 by 120 millimetres, and 100 and 140 horse-power, fourteen cylinders, the dimensions being the same as before, as the larger motors are simply two of the smaller ones coupled together on the same crank chamber. The weights are respectively 167, 182, 220 and 256 pounds. Figure of head resistance for all types, 10.

HELIUM STAR TYPE

Figure 12. The Helium rotating unit shown is a five-cylinder 100 horse-power motor and weighs 275 pounds. A three-cylinder radial is also made, two stroke and double-acting. The crankshaft receives, therefore, no less than six impulses per revolution. There are no valves. The cylinders are made of steel and the crank chamber of a special aluminum bronze alloy called Tena. The three-cylinder engine is made in two types, 45 horse-power and 60 horse-power, the dimensions

being respectively 90 by 90 millimetres and 100 by 100 millimetres and the weights 155 pounds and 181 pounds. Larger elaborations of this engine are the six and ten-cylinder "Degyroscopic" models, in which two engine units are coupled together so as to rotate in opposite directions. These double motors are rated re-

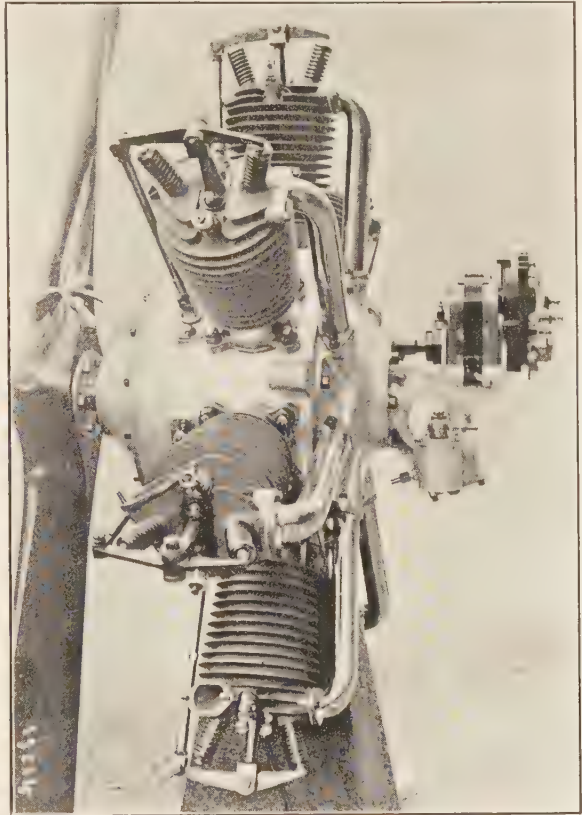


FIG. 17. R. F. P. RADIAL TYPE C. PAGE 72

spectively at 120 horse power and 200 horse power, the larger models having no less than twenty crankshaft impulses per revolution; the consequent torque is, therefore, something closely approximating to that of the turbine. Figure of head resistance, 45 horse-power, 7.5; 60 horse-power, 7.8; 100 horse-power, 10.0; 120 horse-power, 11.0; 200 horsepower, 11.0. The engine is illustrated on page 65.

Type B. Water-cooled stationary motor. The 55 and 80 horse-power three-cylinder Helium engines are of the car type and have bores and strokes of 90 by 110 millimetres and 100 by 110 millimetres, the weights being 220 and 300 pounds respectively. Larger engines of double the power of the above are made with the cylinders arranged V fashion.

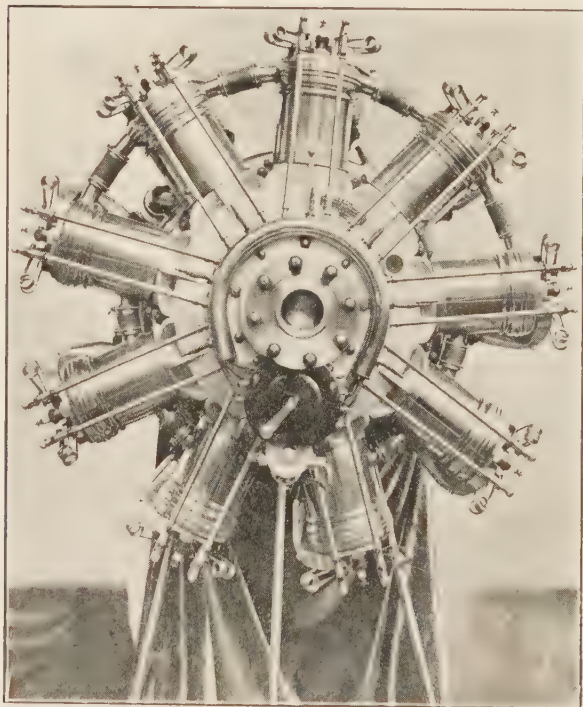


FIG. 18. SALMONSÉN NINE-CYLINDER STAR TYPE A

Evidently the makers of the Helium engine are desirous of fulfilling all possible requirements, as they make a third type (type C), an air-cooled standard radial. The dimensions of the parts of this model are the same as those of the rotating-cylinder type, practically the only advantages being that in the latter steel cylinders are used; standard models are of cast-iron.

L'AVIATOR THREE-CYCLE ROTARY

Figure 13. This is a rotating three-cylinder, two-stroke valveless

engine, in which the filling of the cylinders with mixture is accomplished by a pump in much the same manner as the well-known British N. E. C. A rotating distribution part is arranged by carrying an annular sleeve upon the fixed crankshaft, this sleeve communicating with the inlet ports in each cylinder through pipes arranged as shown in

the sketch. The pump is designed to deliver a scavenging charge of fresh air immediately before the entrance of the fresh gas. The same engine is made in multiples of the above three-cylinder unit, the dimensions being as follows: Three-cylinder 35 horse-power, 110 by 130 millimetres, weight 145 pounds; six-cylinder 50 horse-power, 110 by 130 millimetres, weight 165 pounds; nine-cylinder, 75 horse-power, 110 by 130 millimetres, weight 220 pounds. Figures of head resistance, 6.6, 10 and 10.

NIEUPORT TWO-CYLINDER OPPOSED

Figure 14. This excellent little engine is of the horizontal two-cylinder opposed type, having air-cooled cylinders, the individuality of

which is that they are screwed into the aluminium crank chamber and secured with a locknut. The valves are in the heads and are operated by two separate tappet rods. Lubrication is by a positive pump, worm-driven from the magneto driving shaft. The carburetter is placed low down and behind the crank chamber. One other notable point is that the whole engine is supported by brackets which form rings round the cylinders, the whole of the weight being carried thereby. Rated at 28 horse power, the engine, in which

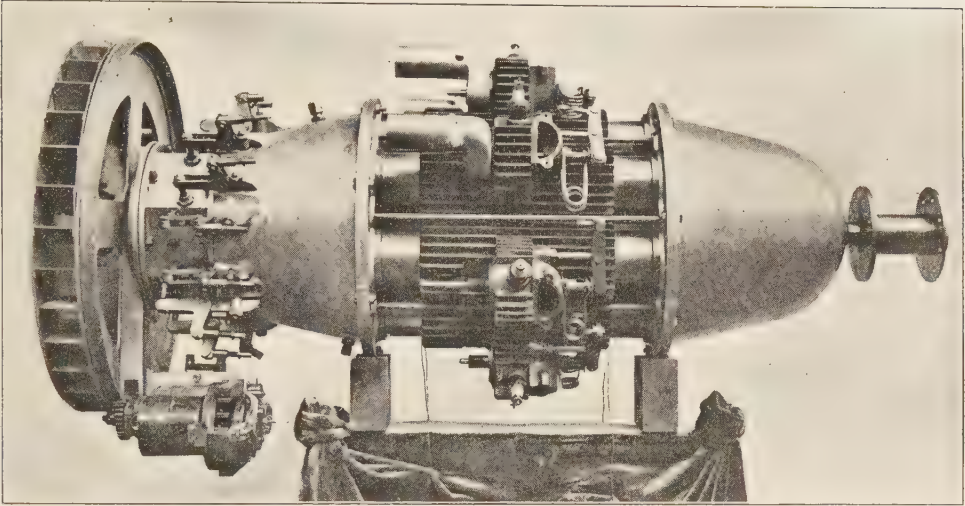


FIG. 18. SALMONSEN TYPE B. ROTATING CYLINDER, AIR-COOLED. SEE PAGE 73

workmanship and material appear to be alike irreproachable, has a bore and stroke of 130 by 135 millimetres. Figure of head resistance of this motor, 3.2.

RENAULT V TYPE

Figures 15 and 16. Represents the 90 horse-power twelve-cylinder and the 35 horse-power eight-cylinder. This famous engine is air-cooled and

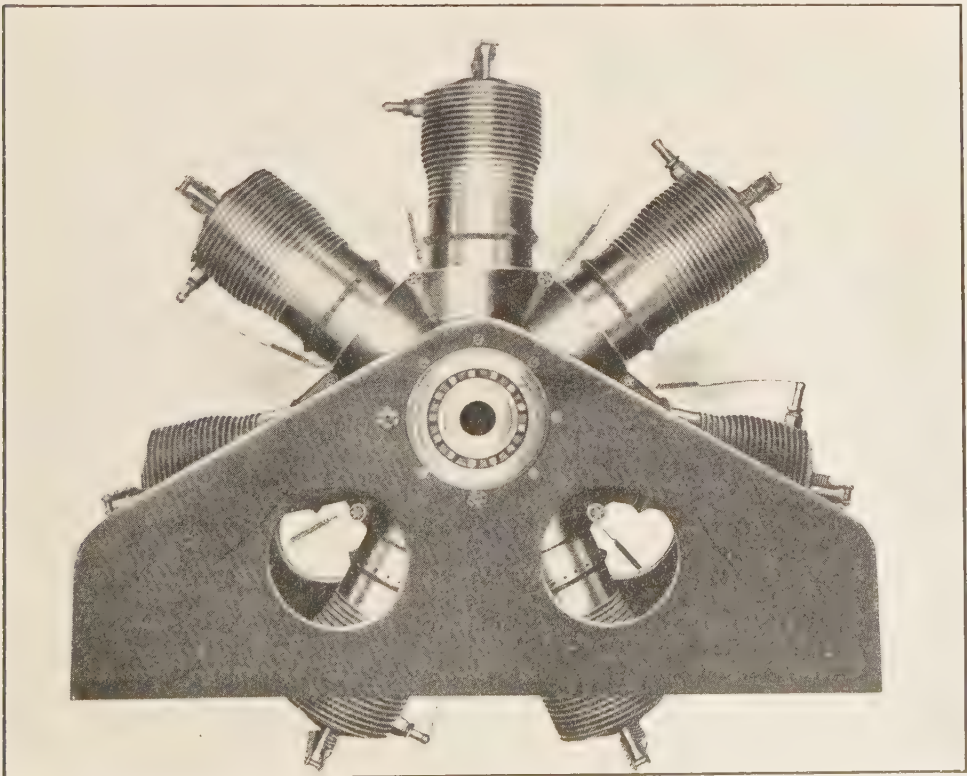


FIG. 19. GYRO SEVEN-CYLINDER ROTATING. SEE PAGE 74

of the V type, with cylinders placed at 90 degrees. The valves are contained in pockets, the exhaust being operated by an overhead tappet gear. The whole engine is covered in by a kind of bonnet, at the rear end of which is a large blower maintaining a forced draught between and around the cylinders, the space above and between them being en-

pounds; 50 horse-power eight-cylinders, 90 millimetres by 120 millimetres, weight 380 pounds; 70 horse-power eight-cylinders, 96 millimetres by 120 millimetres, weight 400 pounds; 90 horse-power twelve-cylinders, 90 millimetres by 140 millimetres, weight 640 pounds. The figures of head resistance are respectively 3.6, 5.1, 7.2 and 8.

R. E. P.

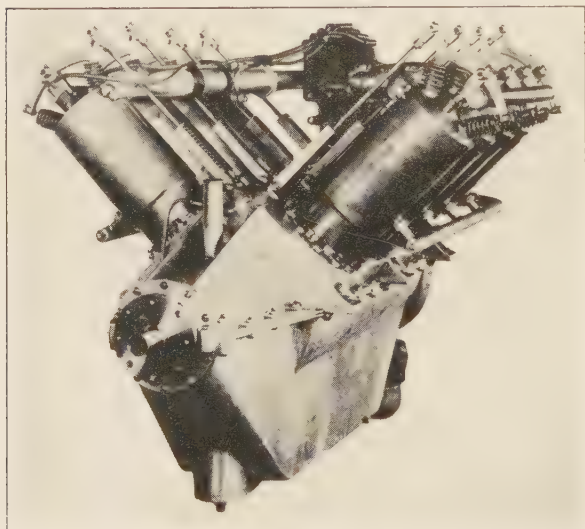


FIG. 20. CURTISS EIGHT-CYLINDER V TYPE

tirely covered in. The propeller shaft forms an extension to the camshaft, and accordingly runs at half the speed of the engine. This feature is introduced on all the Renault motors. The latest type, viz. the 90 horse-power twelve-cylinder, is illustrated, from which it will be seen that it has two separate six-cylinder magnetos. A special feature, and a very excellent one, of these engines is the presence of steel tubes to take the place of the usual cast supporting arms. The other view shows the 35 horse-power engine with the cooling fan eliminated. The various Renault types and sizes are as follows: 25 horse-power four cylinders, 90 millimetres by 120 millimetres, weight 140 pounds; 35 horse-power eight cylinders, 70 millimetres by 120 millimetres, weight 240

Figure 17. Radial Type C, seven cylinders, 90 horse-power, bore and stroke 110 millimetres by 160 millimetres, weight 465 pounds. The chief arrangement of this engine follows the lines of the Gnome, as will be seen from the illustration. The valve, gear, inlet, piping, etc. are the same as in the fan-shape motor. The valve-actuating cam runs at one-quarter the speed of the crankshaft, and is driven by an internal toothed gearing; crankshaft, single-throw.

Figure of head resistance, 8.

Fan Type A. Five cylinders, 40 horse-power, 100 millimetres by 140 millimetres, bore and stroke, weight 230 pounds. The special feature of this engine is the arrangement of the cylinders, which are staggered in a fan-shaped form about the crank chamber, so that three of the pistons drive on to one throw of the crankshaft and two upon the other throw. The cylinder heads are hemispherical. The stems of the inlet and exhaust valves are inclined away from one another, both being operated by a single push and pull tappet rod which is worked by a specially formed single cam which rotates at one-quarter the speed of the motor and is furnished with a kind of double tramway. Forming a forward extension of the crank chamber is an aluminium

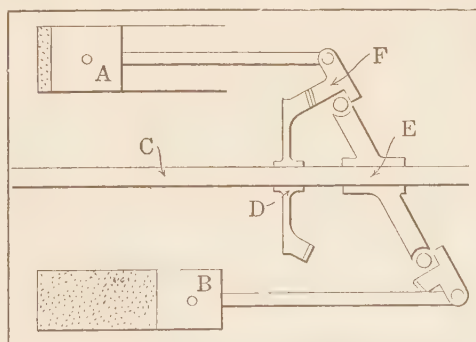
casing in the form of a hollow ring, into which five inlet pipes are branched. At its base the ring communicates with the carburetter, which, in order to prevent the likelihood of its freezing, is carried practically within the top of the oil sump which forms the bottom half of the crank chamber. Figure of head resistance, 6.3.

SALMSON NINE-CYLINDER STAR TYPE

Figure 18. Type A, radial stationary, water-cooled. This engine is constructed with nine cylinders, which are of cast steel with water-cooled heads, the jacket being of spun copper. The valves are side by side in the head, and are operated by tappet rods which spring from the casing immediately in front of the aluminium crank chamber. The circulation is maintained by a pump, the water passing from the lowest cylinder jacket through the jackets of the cylinders on each side of the engine to the top one. The inlet pipes and carburetter, etc., are carried immediately behind the cylinders. The cylinders have at their base an annular groove, by means of which they are kept in position by the halves of the crank chamber. The larger engines are also made with a two-to-one drive to the propeller shaft, the housing for the gear being supported from the cam-shaft casing. The dimensions of this engine are as follows: 110 horse-power, nine cylinders, 120 millimetres bore by 140 millimetres stroke, weight 350 pounds. Figure of head resistance, 11.8.

Type B. (rotating cylinder, air-cooled). This motor is strongly reminiscent of the Lamplough engine, and consists of seven double-ended cylinders arranged in a circle, so that their axes lie parallel with one another. Each cylinder has two oppos-

ing pistons which move in opposite directions. The crankshaft (if it may be so called) lies in the centre of the circle of cylinders, and is arranged as shown in the small diagram reproduced herewith, which shows, however, only half of the cylinder arrangements. In this A and B are two opposite pistons. C, the crankshaft, is stationary, and is for the purpose of the present explanation in one with the bevel pinion D, and carries an oblique plate E, which in turn carries on ball bearings a rotary ring F which meshes with D. The pistons are connected to different points of this ring F. From the diagram it will be seen that if C is considered as rotating, the angle of the plate E causes the pistons A and B to reciprocate in their cylinders and, of course, exactly the same thing takes place when the crankshaft is kept stationary and the cylinders allowed to rotate about it. The crankshaft carries two oblique plates inclined to one another in such a way that the pistons approach and depart from another symmetrically.



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FIG. 21. DIAGRAM OF SALMSON MOTOR

The whole of the engine is intended to be surrounded by a cover, in the end of which is a centrifugal fan carried at the opposite end of the engine to that at which the propeller is fixed. Rated at 60 horse power and with a bore of 75 millimetres and

an effective stroke of 260 millimetres, the Salmson parallel-cylinder engine weighs 220 pounds. Figure of head resistance, 4.

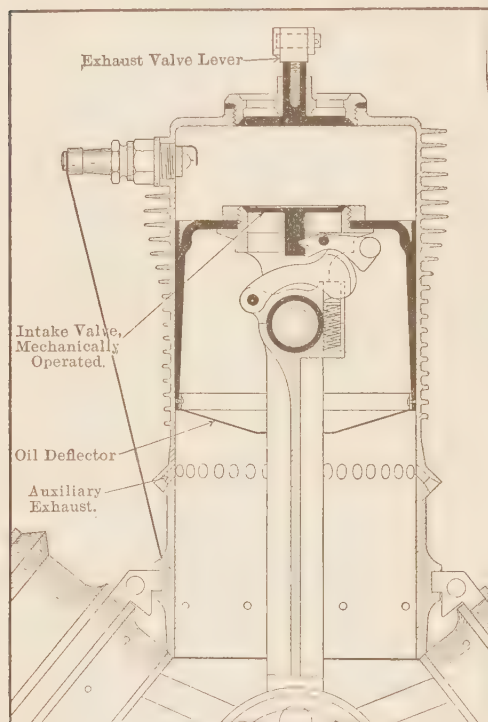


FIG. 22. DIAGRAM OF GYRO ROTATING MOTOR

GYRO SEVEN-CYLINDER ROTATING

Figures 19 and 22 illustrate the Gyro seven-cylinder rotating motor, which is no doubt at this time the leading air-cooled American-made engine. It is similar in design to the French Gnome engine, with the exception of some of the mechanical details, the changes made have undoubtedly improved the reliability of this engine over that the Gnome. In Figure 22 it will be noted that the bottom of the piston head has an oil deflector which is shaped like a saucer with a slot, allowing the connecting rods passage back and forth, and the oil splash is reflected against the side of the cylinder wall rather than being thrown to the top of the piston head.

This assists greatly in the lubrication of the cylinder. The intake valve is mechanically operated. This feature undoubtedly makes the accuracy of this engine far superior to the Gnome. The auxiliary exhaust-ports idea is not entirely a new one, although one of the new features is the elimination of piston rings. A recess has been machined out in the top portion of the piston, leaving a very fine finned edge which expands and contracts equally with the cylinder wall. This gives the piston a very close fit to the cylinder wall and under the compression stroke it has a tendency to stop any leakage between the two walls.

A most valuable feature peculiar to the Gyro motor is its facility of cranking and starting. The exhaust mechanism is provided with a simple device whereby the closing of the exhaust valve may be delayed through any portion or all of the compression stroke.

The motor is started with compression entirely released, in which condition it can be spun about its shaft with great ease. By a simple stroke of a ratchet and lever, the motor may be given initial spin from the aviator's seat from any desired location. The spark and compression are then thrown in and the engine speeds up at once or gradually, according to the movement of the compression lever. This compression-release lever plays an important part in starting, in slow-running when desired and in absolutely cutting off the power regardless of charge or ignition. For hydro-aeroplanes and other purposes the valve of a means for ready starting without assistance and of a perfect speed control under all conditions of landing and flight need only be suggested to be appreciated.

The Gyro motors are now being

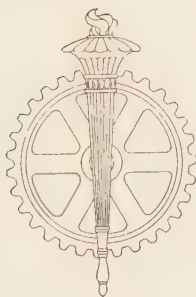
made in three sizes, of three, five and seven cylinders, giving respectively 22.35 and 50 horse power, all being of the same bore and stroke, 110 by 120 millimetres. This engine weighs about $3\frac{1}{2}$ pounds per horse power, with a figure of head resistance about 10.

CURTISS EIGHT-CYLINDER V-TYPE

Figures 20. The Curtiss 80 horse-power, V-type water-cooled, eight cylinders, probably leads in the American manufactured water-cooled engine. This engine has given wonderful satisfaction in every 'plane in which it has been installed. It is built on the well-known Curtiss motor lines and is equal in efficiency, duration, reliability to any of the foreign-made engines of this particular type and size. Its bore and stroke is about 110 by 120 millime-

tres, 80 horse-power, weight 400 pounds. The figures of head resistance are 7.2.

There are a number of other American engine manufacturers turning out and improving motors for aviation purposes as the progress advances. The Hall-Scott, Kurkham, Wright, Max Motor, Roberts, Call, Leighton, Fox, Frontier Aerial, Bates, and Elbridge are American manufacturers who are turning out a water-cooled aeronautic motor. The Detroit Aeroplane Co. and the Gray Eagle Motor Co. supply the market with an air-cooled motor. This is about the extent of the American manufacturers in the motor line. Most of these motors are improving in detail, design, and duration, and undoubtedly some of them have come to stay.



THE GASIFICATION OF FUEL

IV. CONSTRUCTIVE SUGGESTIONS FOR FUTURE PROGRESS IN PRODUCER DESIGN

By Charles Edward Lucke

Dr. Lucke began this study in our January issue with an analysis of the fundamental processes carried on in the producer. His second paper took up the general principles of producer arrangement that would best further these processes. He advanced next to the discussion of typical forms of gas producers, showing diagrammatically the relations of fuel bed and coal and blast supply. On account of the magnitude of the subject this part of the discussion was necessarily subdivided. We come now to the demonstration of the last type—the double-fire producer, "typical of most interesting possibilities not yet realized," together with the author's constructive suggestions for further development of the art—THE EDITORS.

IN the foregoing parts of this discussion an outline of fundamental processes occurring in the producer was followed by an analysis of the primary structural features of producer construction, and that in turn by an analytical examination of the characteristics of various types. Those so far considered were producers with up-draft, with steady and with intermittent top fuel feed and with bottom fuel feed; producers with down draft, and producers with up-and-down, cross, or double draft. These were illustrated by Figures 3 to 8.

More complete and controllable separation of the three processes of volatile distillation, volatile decomposition or combustion and coke reduction, is possible in the forms of structure illustrated in Figure 9, A, B, C, D, E, in varying degrees; and these forms are typical of most interesting possibilities not yet realized in practice, which are nevertheless engaging attention of some of the best thinkers of all nations interested in general fuel gasification. All are forms of the so-called double-fire producer, some using two different fuels at the same time and others but one, some with two points of coal feed, even for a single fuel, and others feeding all coal at one point, and for the first time il-

lustrating one possible method of handling a sticky caking coal. Imperfect as these are they nevertheless stimulate the hope of attainment of the universal producer, gasifying any sort of fuel that will burn, and yielding very nearly the same gas no matter what the fuel, though in some cases a secondary fuel is necessary to help out. The form shown in Figure 9 A is perhaps as simple as any. In it coal is fed to a regular furnace grate and combustion chamber at the left, and at the same time to a down-draft producer at the right; the products of complete combustion from the common furnace enters the down-draft producer bed near its top, and are reduced by the coke it contains to CO and H₂ as combustibles without carbon or tar by-products, yielding a gas quite free from hydrocarbon—provided only, the down-draft chamber contains nothing but coke or charcoal below the furnace connection line. To the left-hand or furnace chamber may be fed anything that will burn—grease, sawdust, garbage, wood, peat, lignite, caking or non-caking bituminous coal, anthracite, coke or charcoal; but in the right-hand reducing chamber the fuel is confined to one that will produce a good fixed carbon bed. Exactly the same sort of action takes place in the

form 9 B, with an up-draft reducing bed, connected with which is shown more than one complete combustion furnace in which different fuels may be burnt at the same time. One, for example, may be given a form suitable for garbage burning, while the other is burning a caking coal; the

tillation, volatile combustion, and coking troubles are under reasonable control. If, however, coking be incomplete on the furnace grate, the gas will be quite similar to that of an ordinary down-draft producer handling a less troublesome coal than that fired, and if not enough coke is pro-

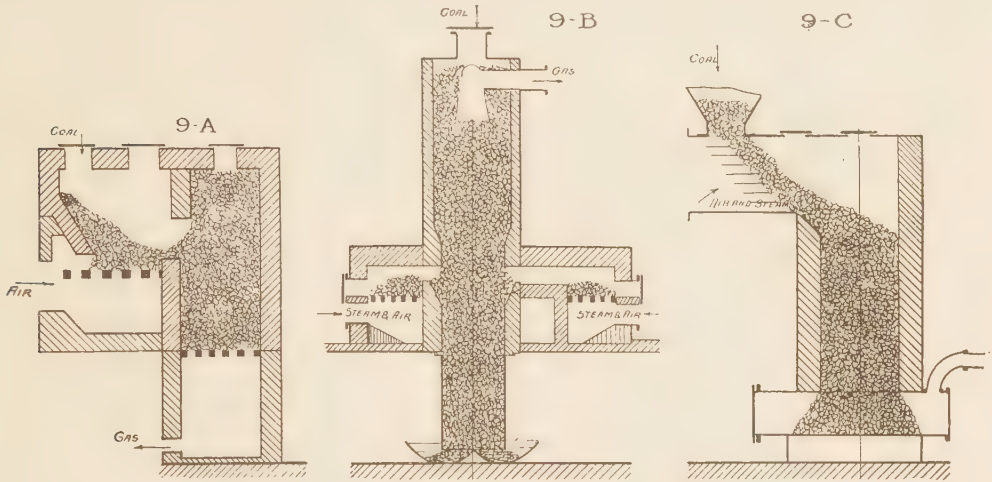


FIG. 9. PRODUCERS WITH DOUBLE FIRES

reducing bed should, however, be confined to a fixed carbon form of fuel, or volatile will be added to the gas. An arrangement contemplating the use of but one fuel, and that a coke-producing sort, is illustrated in Figure 9 C, where the coal is fed to an inclined step grate which may, however, be given the form of any of the standard mechanical boiler-fire stokers on which distillation takes place, volatile burning in the combustion chamber above the coal bed and coke unconsumed on the grate being discharged to the main coke down-draft reducing bed.

If the fuel contains not too much volatile in proportion to fixed carbon, and not too much fixed carbon be burnt on the grate, there will be enough coke sent down to the reducing chamber to convert the whole of the fuel to tar- and soot-free gas, containing only carbon monoxide and hydrogen, and at the same time dis-

duced to reduce the products of combustion from the furnace, however well the grate process may be carried out, the lower reducing bed will sink and unfinished coke must be discharged from the furnace to keep it up. There are limiting conditions at which the pure process fails, and it becomes a mixed one approximating the straight down-draft producer, but with better control than is possible with a single bed. Of course, if a supply of coke is available to make up reducing-chamber deficiencies, this arrangement can be made to gasify to a standard gas anything that will burn.

Down-draft chambers, as has been pointed out, are necessarily intermittent, as the producer must be stopped to clear out ash, perhaps once a day, unless water-sealed at the bottom with means for extracting ash from beneath the water surface, and up-draft would be preferable for this

reason; but when products of combustion from a furnace are to be sent through an up-draft bed, the grate difficulties become serious, as the gases are so hot. Such an arrangement would, however, be operative if opened for clearing the bed, acting as a straight air-blast producer without steam during the open period, the

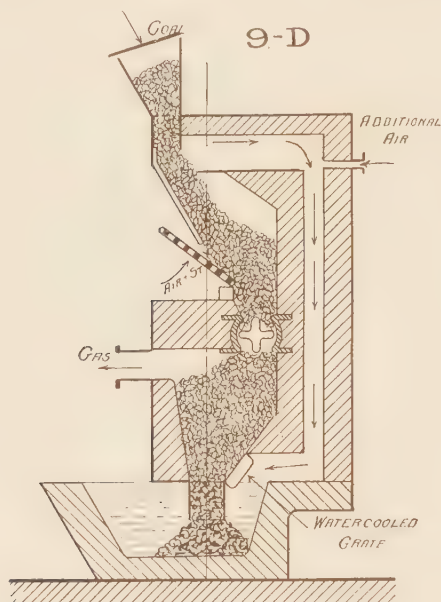


FIG. 9-D. DOUBLE-FIRE PRODUCER

upper fire standing dampered or banked meanwhile. In this case there will be two up-draft fires, similar in this respect to the forms shown in Figure 8, B and C, but different otherwise, and one such is shown in Figure 9 D, where the coke from the distilling furnace is fed through a mechanical lock to the lower reducing chamber, while products of volatile combustion are by-passed around to its bottom, entering through a water-cooled grate. Of course, metal locks in the middle of such fires that are tight enough to prevent leakage of volatile products through to the gas outlet without reduction, and that will resist the action of the gases and high temperature are at present impracticable; but the

arrangement has sufficient of process interest to be worthy of study.

Complete separation of fixed-carbon reduction and all other processes is possible only with complete physical separation of the two fuel beds, in which they take place, by sufficient space to permit the long hydrocarbon flames to burn themselves out before entering the coke bed; for from that time there will be not enough air to complete their combustion, and the final gas will contain variable hydrocarbon and soot. Such an arrangement is shown in Figure 9 E, as constructed under the direction of the writer for experimental purposes and operated with a caking Virginia coal. The upper chamber consisted primarily of a standard Roney stoker, as supplied by the Westinghouse company, while the lower one was practically a standard down-draft producer having hollow water-cooled grate bars carried on a similar water-cooled cast-iron sill, the water for which passed from the dust scrubber to the water-sealed holder ring, thence to grate sill and bars, spilling into the lower chamber and escaping to an overflow. The ash-pit shell was made of the annular gas-holder form, water-sealed top and bottom to insure absolute tightness, and counterweighted to permit of quick opening for clearing without removal of bolts or other fastenings. At the start, the reduction chamber was filled with beehive-oven coke in small lumps and a fire of about the same coking coal was built on the stoker grate; gas was produced in less than an hour, of good quality, tar- and soot-free, and burned with an absolutely non-luminous flame, without change for seventeen hours on the first run, at the end of which time the coke had so decreased as to make a stop necessary. This indicated that the coke discharged from the stoker was insufficient in

amount, though of good quality, quite gas-free, and it was thought that increase in feed with changes of an adjustment would correct the fault; but it did not. Repeated trials showed that with the coal used (which chemically, should have produced more than enough coke to reduce the products of volatile combustion, permitting of some excess air above the fire) it was quite impossible to keep up the supply. This proved that with the Roney stoker the volatile could not be burned

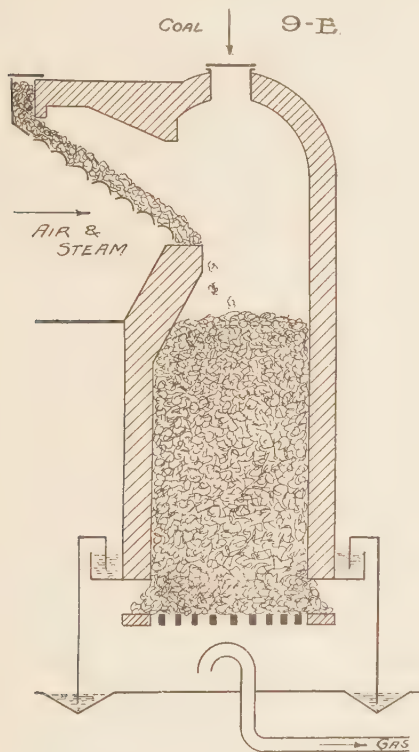


FIG. 9-E. DOUBLE-FIRE PRODUCER

without considerable excess air, and that at the same time much of the coke burned on the grate itself, and this suggested the substitution of another form of grate or hearth for the primary fire, to give a higher coke yield and burn the volatile with less excess air. This was not done, however, because of the expense involved; but a lower-volatile coal, even of the

coking or sticky variety, could easily have been handled. By this experiment was proved on a practical scale the complete possibility of handling any fuel that will produce enough coke to reduce its volatile products, gasifying it without any by-products to a far more constant gas than is possible with producers yielding gas containing any of the volatile of the coal, and the constancy is moreover attainable no matter how the load may change. Treatment in this manner of fuels having high volatile yields is thus reduced to the design of the primary furnace chamber for distilling all the volatile without loss of coke and burning it without too much excess air; but of course some fuels will not yield enough coke to accomplish reduction, in which case coke may be added, or one of the previously described processes used in its place in which some of the volatile appears in the gas not completely changed.

It was previously pointed out that the gasifying results depended on four things: maintenance of blast conditions, treatment of the volatile, maintenance of bed conditions (or homogeneity of gas flow) and ash and clinker interferences; so there remains to complete this review a brief discussion of the last two, which are practically one.

Air supplied to a bed of coal, coke, or other solid matter flows through it in paths selected by itself, and the time of contact depends on the length of path for a given blast condition and depth of bed, while the reduction effect of the time of contact depends on the condition of the carbon surface for any given temperature. This indicates the importance of some knowledge of the path taken by the gases through the bed and condition of the carbon surfaces swept over, in order that the relative value of different arrangements may be judged and the

possibility of suitable control as well. Gases will flow through the bed in a non-homogeneous manner, no matter whether it be a thin boiler fire or a thick producer bed, for the simple reason that they will choose paths of least resistance. Wherever the resistance is high, the gas flow will be feeble; wherever free openings exist, there the gas flow will concentrate; and it is part of the generally understood work of boiler firemen, especially with anthracite coal, to keep the "black spots" covered, these indicating points where coal has first burnt up because of an accidental less resistance at these points. These same conditions exist in producer beds, but are not visible at all in down-draft producers, though when bad they show by "bright spots" on top of up-draft producer beds, the bright spot indicating a place where CO_2 is high because the oxygen has either not been entirely consumed at that point or the CO_2 has not had time enough to reduce and cool the spot in becoming CO , while the short circuit in the boiler fire shows dark because the fuel is all gone and air is blowing through the ash. The seriousness of these short-circuit or low-resistance paths is to be realized when it is remembered that they are self-intensifying, the very flow that starts along one of them making the openings larger and concentrating more and more of the flow along it, just as does a leak in a silt or sand levee or reservoir bank enlarge itself; in the former case by combustion of the walls of the gas passage, in the latter by physical carrying away of the banks. Where such a path exists, it is quite possible for free oxygen to escape after traversing the whole bed; if not so bad, the CO_2 will be high in spite of high temperatures; in any case, bad gas is the result from failure to reduce CO_2 to CO , or actual

combustion of some of the CO formed by free oxygen that escaped uncombined. It is likely, therefore, that no two cubic inches of gas that finally are discharged from a producer bed have occupied anywhere near the same time in passing through, or been in contact with carbon in the same surface condition and same temperature for equal times; for the existence of short-circuit paths is absolutely certain.

A striking illustration of this on a large scale that came to my attention is worth recording. In this case several up-draft pressure producers of the same design and size, standing side by side, were supplied with blast from a common header pipe, each receiving its share through a branch connection containing a damper. When all were working and dampers wide open, it was quite impossible to keep one from getting too hot and another from turning almost cold, simply because the whole bed resistance of some one would be less than the others, in spite of any poking, ash removal, or firing attempts to keep them of equal resistance. That one with the least resistance would of course take more air, burn its coal faster, and further decrease resistance, so that if left alone that one would turn into a common furnace, yielding practically no gas at all, while the others gradually produced less and less gas as their air deflected itself toward the free path bed. Of course, things were not allowed to go so far, and when one showed itself getting too hot the damper was partly closed and more coal fired to thicken the bed, but almost immediately this would have to be repeated in another, with the result that none were ever operating quite right, the gas was constantly varying, and five producers yielded nowhere near five times the gas that one could. Once the cause of

the trouble was realized, it was a simple matter to correct it, for correction involved nothing more complicated than a transference of main blast resistance from the beds to the dampers—that is, an increase of the blast pressure in the main so that all dampers could be operated nearly closed when producers were operating at full capacity, and each one passing all the air that could escape, with loss of pressure through the damper openings available.

Just the same sort of thing takes place within any one bed, only the damper remedy is not available; nothing but poking the bed to pack it where it seems loose, removal of ash and clinker from points where collection offers obstruction or non-combustible paths is available; and so long as we have beds for reduction, their maintenance must be a source of trouble, to be corrected partly by management and partly by design—the latter being preferable, but dependent on knowledge and experience for execution.

Besides the initial accidental paths of lesser resistance through the bed, there are others of the same nature equally bad; thus shrinkage of coal during combustion is one ever present. If a hundred cubic inches of coal finally turn into ten cubic inches of ash, there is a 90 per cent shrinkage, and this is common enough; higher ash content means less shrinkage, but the amount of volume reduction will always be considerable, while with a coking coal this reduction is preceded by a swelling during the melting and coke-setting period. Change of volume being three-dimensioned, the tendency will be for bed to fall on shrinkage and to rise on expansion, and these movements take place without difficulty except in one case—and this occurs when the bed tends to form an arch within itself, just as certain pul-

verized materials will do, resisting outflow from bins or spouts when openings are made in the bottom. Certain coals, and to a small extent all coals, will when burnt away fastest at the center leave a hollow space, the superimposed material supporting itself by a natural arch—a fact known to producer operators, who in poking a bed from the top frequently have the bar slip through three or four feet with a general cave-in of the bed. Clinkers that form next to the side walls and cling because they fuse to or flux the brick lining, will support a similar top layer of coal with nothing but open space below, so that side poking along the walls is just as necessary to detach these as to break down center arches.

No matter how carefully hand poking may be done to keep the bed equally compact in all parts there are certain influences that cannot be overcome; and it may be that mechanical appliances will some day be developed to meet some of them, as design of general arrangement has already done in part. For example, the gas-flow resistance at the producer walls is always less than through an equal distance in the bed, first because the wall is smooth and flat, and second because of a linear shrinkage across the diameter of the bed which tends to draw the fuel away from the walls as it burns. Correction of a shrinkage spaces next the walls is attempted by inclining walls inward and downward, but as this tends to promote arching, it is of questionable value unless very carefully done with reference to the type of fuel, while hand poking along walls and use of otherwise excessive depths of bed must be relied upon to correct naturally deficient wall resistance. Increasing of bed depth cannot be carried too far, however, because the strongest man with the usual one-inch solid bar

can scarcely drive it four feet into an ordinary bed, and not that far when the bar gets hot and soft. As such work is very exhausting it is human nature for operators to neglect it; so that as a rule it will not be done, especially if the management does not know enough to insist upon regular attendance, or fails to supply suitable appliances for it.

Besides these internal influences affecting the direction and length of path of the gas flow through the bed, are some others that may be regarded as external (though not always strictly so) in the nature of deflectors. The most obvious of these is a large clinker, and with some fuels and insufficient steam in the blast it is not uncommon for clinkers as large as a man's body to form within a bed, absolutely shutting off that portion from gas flow and increasing the rate of flow and decreasing the time of contact of the rest of the bed. This may even be carried so far as to leave insufficient time for as complete reduction as would be possible with homogeneous flow, and the gas, by such simple means as the collection of an invisible and perhaps unsuspected clinker may become bad even when all other conditions are good.

Similar deflecting influences are exerted by the initial velocity directions given to the blast by the passageway through which it enters, and the location of the outlet tends to deflect it toward that point. These are matters of design, and of far greater possible influence than some builders of producers seem willing to admit, as two illustrations that came under my observation will prove. In one case a small size of anthracite was being fired in an up-draft producer, with a pressure blast that was discharged into the bottom of the coal bed, upward through a vertical pipe fitted with an umbrella-shaped cover

that deflected the blast downward and outward toward the walls. Pieces of coal that had been no more than moderately heated but not burned at all could be found in the ash in considerable quantities, and this was traced to the central column of the bed that descended directly over the blast hood, proving that no air, or practically none, rose through the central part of the bed, and that hardly more than two-thirds of the bed area was really active. In another case a suction producer fitted with a grate and receiving its blast under the grate through a side inlet connection to ash pit was found to burn very much faster on the side opposite the blast inlet than where it entered, and to give less good gas than it should, while much unburnt coal escaped through the grate on the blast-admission side. This proved that the blast was swept across the ash pit by its entrance velocity and did not rise through the grate till this velocity was destroyed by the opposite side wall, where it all bounced upward through the bed. Enlargement of ash-pit height and the introduction of some baffles corrected this fault and materially increased the capacity for good gas making, simply because all the bed was made equally active.

A gas outlet close to the top of the bed and at one side will exert almost the same influence, especially if the top gas chamber is small, the gas being drawn toward the gas-outlet side, and flow tending in that direction even within the bed. This is one reason why in up-draft producers there should be plenty of free space above the bed for side-connected gas outlets, and why also central outlets are more desirable than these at the side. The central gas outlet in up-draft producers also exerts another good influence, as it tends to correct the natural tendency toward undue flow next the

side walls; but unfortunately the high temperature has a bad effect on iron connections for this purpose, whether of the conical spout form, leading gas off sideways or, still worse, the through pipe to the bottom of the bed.

This is merely one more illustration of the frequency with which a structure more suitable for the process than another is in conflict with life and maintenance conditions which must always take a leading place, for the best producer, so far as gas is concerned, is of no value if it burns up in a month's service. Up-draft producers with large central feed hoppers force the discharge to the outer ring and tend to promote side-wall flow and for this reason the benefits of slow heating offered by the hopper are in opposition to the detriments of the side-wall gas escape. The same is true, but to a more complex degree, with respect to the blast entrance for up-draft arrangements; side entrance of the blast around a solid hearth hung below the beginning of the side walls promotes wall flow; central feeds would be better, but must be capped to prevent filling with ash (if of pipe form) and the cap is a serious deflector. However, the grate bottom with blast entering over the whole area (whether the grate be circular or in the form of triangular prism laid on its side), and passing through from side to side, with clean-out doors for ash removal, offer fairly good chances of uniform central blast feed, if kept clear of ash which tends to pack tightly and clog the grate. The central circular grate provided with some sort of ash-shaking movement appears to be much the best arrangement for up-draft operation, but as dumping is not possible, such grates must be hung below the side walls with a free space between large enough for clinker removal, or

if fixed at the side wall bottom, there must be available clean-out holes for clinker removal, which can never be so effective as a complete ring between grate and wall. Access to such grates for poking and cleaning is reasonably easy with suction operation, though difficult with closed ash pits needed for pressure operation; and this is one of the strong practical arguments for the abandonment of pressure operation and the substitution of induced-draft blowers beyond the water-cooling scrubber—not, however, practicable when the gas is to be left uncleaned and hot, as it is when generated for furnace heating only. For this sort of service the pressure blast is a necessity and will be until a satisfactory induced-draft blower can be designed that will not be affected by the hot gases, and with the pressure blast the continuous removal of ash is possible only with the water-sealed bottom, which is bad in another respect.

However uniformly or homogeneously the blast rises through the bed, burning the coke regularly and maintaining a horizontal plane of division between ash and coke, unequal ash removal will disturb this plane and distort it into a curved surface. Ash that projects higher into the bed at one point than at another, whether that place be around the side walls or concentrated to one side or the center, and whether caused by drawing down ash faster at the low point or faster combustion at the high point, yields a net result equally bad with respect to gas flow and good gasification of fixed carbon. Carbon cannot begin to burn till air reaches it, so if its lower carbon surface be in the form of a mountain peak or a hollow crater, so will the length of path over which carbon reactions take place be irregular, and the effect on gas making be the same as when low-resistance paths

exist for blast flow through the coke itself. Full bottom grates open to poking or shaking offer the best chance of uniformly taking out ash, but this is of no use unless ash uniformly forms all across the bed, while the water-seal bottom is sure to result in practically no center ash removal, compared to that at the sides. Raking through a water trough under hanging side walls to get out ash will draw nearly all of it from the sides, and unless the ash formed mainly on the sides this form of producer would be quite impracticable; the fact that the construction is even moderately successful is further proof, therefore, of side-wall combustion and central inactivity in the bed.

There are two other influences that play parts important enough in bed-condition maintenance to warrant mention, and these are brickwork leaks and uniformity of size of coke particles. Any leakage of air through the brickwork due to improper bedding or subsequent development of voids between bricks or tiles constituting the side walls is serious, because no matter how perfectly bed gasification takes place, air that thus bye-passes the bed will burn some of it to CO_2 , and the result is the same as if bad conditions existed in the bed and might lead an operator to struggle with this bed to correct possible faults, when as a matter of fact it was all right; and unfortunately there is no known test of air leakage in bed, especially if the leak is from one end to the middle. Of course, in an up-to-date producer a through leak from top to bottom will show by the existence of flame above the bed where there should be none, but as this flame is non-luminous, only skilful observers would notice it.

Non-uniform size of coke or fixed-carbon lumps is also serious, and

doubly so if derived from a bituminous coal; first, because the voids between large lumps are so much bigger than between small ones that the gas passes so much more freely as to make a condition equivalent to a hole, or short-circuit path. When however, the lumps are derived from bituminous coal they give up volatile much faster from the small than from the large pieces, and at a central point of the bed small pieces may be completely coked, permitting the pure carbon-gasification action, while beside them large pieces may be only partly coked, yielding volatile when none is expected. Coke derived from bituminous coal with even moderate caking tendencies will be sure to yield unequal-sized pieces, and actual observation has shown pieces in a quenched bed ranging from the size of a man's head to a hickory nut, the former only partly and the latter completely coked. With such conditions, uniform good gas is a practical impossibility. This is a strong argument for separate controlled coking of a caking coal on grates, hearths, or retorts, in conjunction with means for breaking up lumps to reasonably uniform size, lack of exact sizing being in this case of less consequence because completeness of coking is not left to chance within a large bed out of sight and beyond control.

In this same connection there should be mentioned another characteristic of certain fuels, notably lignite and peats. It often happens that lignites, as mined, hold a large amount of water of crystallization to which is due their lump form, but which when expelled by heating leaves a pile of sand-like particles where a hard lump was before. This will pack a bed so that practically no air can penetrate, even with considerable blast pressures; but fortunate-

ly such fuels sometimes contain enough bituminous matter to subsequently cake and form new lumps, if they get a chance, and certainly they must be given a controlled and not an accidental chance, if they are to be adequately gasified. Peats on heating often leave a residue that similarly pulverizes, though not from quite the same cause, their coke or its preliminary equivalent simply crushing under the weight of the superimposed column, and then treatment is a most difficult matter as a consequence.

Finally, under this class of bed conditions more or less controlling the gasification of the fixed carbon is the character of the surface of the coke lumps themselves as presented to the passing gas for chemical reaction. A layer of dense ash or a layer of fine carbon deposited from the decomposition of hydrocarbon gases and vapors retards reaction; fresh surfaces permit a most speedy reaction in proportion to the softness and fineness of the holes in the coke, which latter is greatest for charcoal. Furthermore the reaction of oxygen to carbon dioxide proceeds much more readily than that of carbon dioxide to monoxide, and for this reason coated or hard carbon reacts better when brought into contact with the blast than when relied upon to reduce carbon dioxide. This is an argument in favor of counter-current flow of coal and blast, which, it is interesting to note, is contrary to the most satisfactory conditions for treatment of volatile in structures of the single-bed class. Thus, it was found that the down-draft bituminous single bed gave a better treatment to the volatile, whereas it appears that fixed-carbon surface conditions require an up-draft.

From what has been said of a few

of the relations between process and structure necessarily very brief and not one per cent of what might be said, it must be clear that there are not only a great variety of processes available forming parts of the general process of gasification and even more structures suggested for executing them, but that one condition is generally in conflict with another almost equally desirable. From this maze, which appears hopelessly confusing at first, some principles emerge clearly practicable and good, while by reason of lack of knowledge (not surprising for an art so young as uniform gasification of fuels) others are yet obscure.

Furthermore, that calculation, experiments, and a good mixture of common sense can do much to clarify the situation, but this must necessarily involve much frank, scientifically unbiased, critical discussion common to other branches of engineering, though equally uncommon in this line where the literature of the subject is almost entirely confined to descriptions of structures, to reports of tests without analyses of faulty process actions, or to chemical calculations based on hypotheses not related to structural possibilities of justification.

By critical analyses of the whole of the literature of the subject, one is forced to believe that while much has been done that is creditable, far more is possible; and that while from the pure chemistry of the problem complete and reasonably uniform gasification is possible, the failure to secure it for all natural fuels available (being a purely structural problem) will some day be changed to success. This success means not only a great deal for that man or group of men responsible for it, but far more to the country at large, since it is

concerned with so fundamental a matter as the national fuel supply for heating, lighting, and power generation, by methods that will promote an increase in use and be very much more economical than those now considered standard.

Should it prove, after a better solution of the gas producer problem itself, that (as I believe will be the case) a more or less general pipe-line distribution of fuel in the gaseous form for all purposes, is an economically desirable and feasible project, then the laws of standardization must be applied to the gas just as they have been applied by force to railroad gauges and car couplings, and are now in course of application to the electrical equipment of railroads that must receive each other's cars. In this case it will not do for one gasification plant to make a rich gas with much volatile, and another a weak gas, for not only will it be impracticable for different plants to feed common mains, but (more important still from a broadly economic standpoint) gas appliances for light, heat, and power would have to be designed for different gases and would not be properly interchangeable. The gas must be as uniform as the railroad-track gauge, and the gas-using appliance as uniform as the car coupling or journal box. But this is not all; the gas-generating equipment must be capable of making the standardized gas from any fuel available,

whether the garbage of the city, the refuse or bye-product of the tannery or other factory, the as yet untouched peat bog, or the finest anthracite or bituminous coal in existence, which may yet be the cheapest thing in the region where it is produced. This generation of the standard gas is not the hopeless impossibility it might at first seem as must be clear from the discussion, for it has been shown that all these fuels may be reduced to a gas containing only carbon monoxide and hydrogen as combustibles, and in not very different proportions for the widest sort of range of fuels; and it is for this reason that the development of such gasifying processes is believed to be a thing of very great importance in the long run, though not perhaps of so immediate value as the building of any sort of producer that will make a gas good enough to be used in any specially designed appliance. It is only by the shortest of steps, the exertion of an infinity of patience, the expenditure of much experimental research money, and the heartiest sort of "get-together" co-operation of all who know anything of the problem, that we can hope to pass beyond the small successes attained, to the larger possibilities that may contribute most to general welfare, in this field of substitution of gaseous for all the forms of available fuels, most easy of distribution, and equally available for heat, light, and power.



EDITORIAL COMMENT

MONOPOLY AND PROGRESS

SOMETHING approaching consternation seems to have been excited in the popular press by the decision of the United States Supreme Court in the mimeograph patent case recently rendered. And yet this is in direct line with the entire chain of decisions in similar cases so clearly summarized by Mr. Edwin J. Prindle in his review of "Patents as a Factor in Manufacturing," which appeared in THE ENGINEERING MAGAZINE from September to December, 1906. Coming at this particular time, when the question of the so-called "patent trust" is already agitating the public, the decision seems likely to provoke the introduction of new Federal legislation, aimed at a limitation of monopoly rights now granted to patentees.

The merits of the bills already prepared or foreshadowed may be open to debate. The safeguard of the representative republican form of government is that the processes of its action are deliberate, and the soundest wisdom has time and opportunity for expression before any public act takes effect. It is extraordinary that newspapers addressed to intelligent readers fall into the incredible error of identifying Chief Justice White's proposal, that the fault of the existing law be corrected by act of Congress, with another and a startling proposition lately put forth—that such a decision as this lately handed down by the Supreme Court be overruled and reversed at the polls by popular vote.

The former method is that of a representative republic, under which the only stable governments of the world's civilizations have existed. The other is the method of a direct de-

mocracy, which has no historic precedent for its stability. If it be considered a better way, (as it is by many earnest and sincere minds) it must be recognized that it is also a revolutionary way, and that the end to which it leads cannot be foreseen or foretold.

PROPHETIC HISTORY

IN the introductory note to Mr. Kershaw's series, which begins in this issue, its special significance and salient interest to an American audience are briefly stated. Events influenced by the labor movement, politically and economically, in Germany and England, are like recording gauges reporting accurately conditions farther down the stream upon which we in this country are embarked. We shall reach the same points a little later in our course; and we will be most wise if we study attentively, earnestly, the lessons which may be drawn from British and Continental experience today. For the analogy of the stream does not hold absolutely. What is to come may be changed, to some extent at least, by measures well conceived in advance, and courses determined and adopted now. We should profit immensely by the lessons that may be learned from the civilizations that are encountering our coming problems under our eyes before we ourselves have to solve them. It will be most unfortunate if in this, as in so many other things, we insist upon ignoring the open record book of human successes and failures, and "learn over again at our own cost the lessons of experience which the world's history is ready to teach us for the asking."

A STUDY OF PREVENTABLE WASTE

A VERY interesting and potentially important study is announced by the Department of Industrial Research of the University of Pittsburg—a study of the smoke problem from the broadest point of view with recognition of all its relations, technical, economic, legal. The chief lines of investigation so far laid out, each to be carried on by one or more specialists, are the engineering aspects of smoke production and smoke prevention; the effects of smoke on health, plant life, and buildings; increased cost of living due to damage and dirt; and the legal questions arising out of the conditions of smoke production. By co-ordination of these various researches, it is hoped to fix the status of the problem in its various phases on a scientific basis. Much loose statement and consequent misapprehension undoubtedly exists at present. The disposition of engineers probably has been to underestimate the seriousness of the waste caused by smoke, because of its relative insignificance from the point of view of power generation. It is the indirect effects, the effects experienced by the community, rather than by the smoke producer, that are important—how important, it remains for this commendable research effort to establish; but it seems safe to say that herein is one of the industrial and social wastes that the movement for the promotion of efficiency may well take into its purview.

THE ECONOMIZER

AN esteemed correspondent suggests that certain passages in our article on natural draft in the March issue might be given an interpretation which was not in the author's mind when the article was prepared, and that the argument

should be balanced by some considerations on the other side. As professional discussion is always of the highest value in clarifying the points of a paper, these suggestions are offered in supplement to Mr. Maguire's analysis.

The success of the economizer with natural draft secured by stacks is too fully demonstrated to need assertion. Considering not only number of plants, but total horse power thus equipped, the figures are largely on the side of the natural-draft installation; for the list is headed by the large electric railway systems, such as the New York Interurban, London Underground, Paris Suburban, the great sugar refineries of New York, Brooklyn, Philadelphia, New Orleans and San Francisco, many of the most important cotton mills throughout New England, and others. The merit and virtue of the economizer, of course, is its recovery of heat from the furnace gases; and this direct recovery and other causes necessarily lower the stack temperature; but against this must be set the consideration that for a given horse power developed, the economizer will save an important percentage of the fuel burned and require correspondingly less draft.

Other points upon which emphasis should be laid are those of proper design of the flues and the arrangement of the economizer itself. In many cases an alteration in flue arrangement may give improved draft concurrently with the installation of economizer sections. The increased use of mechanical draft with economizers is indeed most probable; but the increase will result not only from the comparison of present conditions, but from the continuous demand for a constantly progressing increase in the amount of fuel to be burned per square foot of heating surface.

REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA



CENTRIFUGAL ORE SEPARATION

A NEW TYPE OF ORE CONCENTRATOR EMPLOYING CENTRIFUGAL FORCE

William J. Gee—Journal of the Royal Society of Arts

AN important natural law which governs a large number of industrial processes is that which accounts for the property possessed by water and other liquids of holding in suspension particles or grains of insoluble matter, when stirred up with them, and afterwards depositing the solid matter when agitation has ceased. The time taken for the solid matter to settle out of the liquid may vary from seconds, in the case of sand or coarse grit, to days or weeks, in the case of very finely divided material.

In the treatment of ore the object sought is separation entirely as to the specific gravity of the particles without reference to their size. The principle employed in existing mechanical concentrating plants consisting of concentrating tables, vanning machines, etc., may be summarized into one governing proposition, namely that the crushed ore, being suspended in water, is submitted to two forces acting at right angles to each other: (1) the force of gravity, causing the metallic particles by reason of their greater inertia to tend to remain behind; and (2) the flow of the water, which carries away the lighter or gangue particles.

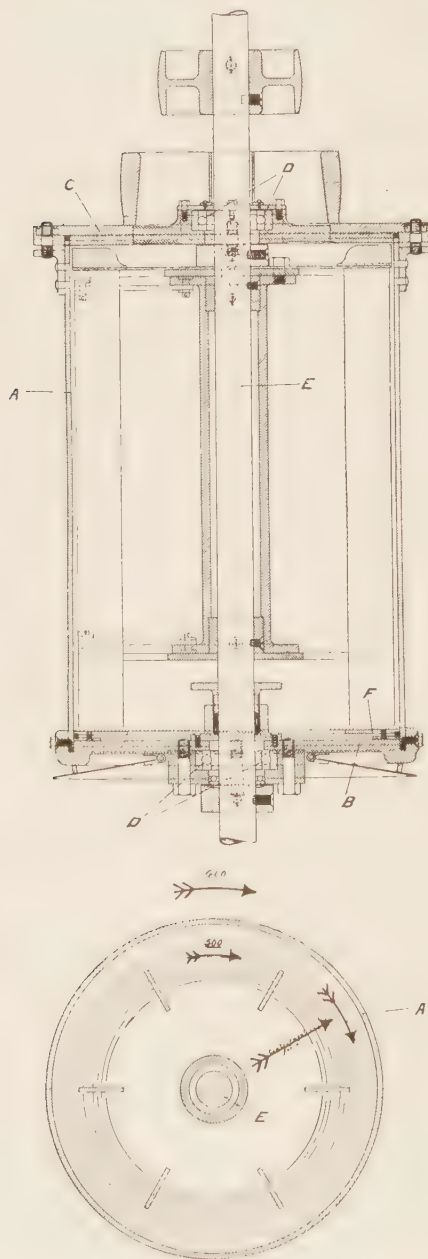
For this purpose the author evolved a separator to carry out these two essentials. This separator is illustrated

in sectional elevation and in cross-section in the accompanying Figure. In this machine the drum, A, is mounted on the base, B, and closed at the top by the cap, C. Ball-bearings, DD, at the top and the bottom of the drum are placed so that the drum may rotate on, but independently of, the shaft or spindle, E. Attached to the shaft within the drum, but clear of it, are a number of radial vanes or blades extending the whole length of the drum and so arranged that the distance for which they dip into the wall of water may be varied, so that the grip of these blades on the water may be adjusted.

The principle of the apparatus is that the drum is caused to rotate at a given speed, and the wall of water is caused by the vanes to rotate within the drum at a greater speed but in the same direction. These speeds and their ratio to one another may be adjusted within very wide limits. The result is that the particles of greater specific gravity are, by reason of their greater inertia, caused to deposit on the drum and remain there, while the particles of lesser specific gravity are carried along with the water and discharged with the effluent.

The method of operating the separator is as follows:—The drum and the vanes are set rotating at the re-

quired speeds, and clean water is fed into the drum until an effluent is observed at the outlet. This indicates



ELEVATION AND CROSS SECTION OF SEPARATOR

that the wall of water in the drum has been obtained. The inflow is now changed to water-suspended ore,

whereupon the separation of the metallic particles is effected as described during the passage of the material through the drum, and the effluent will consist of water-suspended gangue only. The inflow of ore is continued until a sufficient deposit of concentrates is obtained, and it becomes necessary to discharge the metallic material. The discharge is effected in the following manner:—The inflow is changed to clean water, and continued until the effluent is clear. There will then be in the drum only a wall of clean water and the layer of concentrates adhering to the inner surface of the drum. The outlet is connected to the reservoir for concentrates, and the motion of the drum retarded or stopped while the vanes still rotate. The action of the vanes is thereby increased to such an extent that the concentrates are washed off the drum and carried by the continued inflow of clean water to the reservoir. The machine is then ready for a new cycle of operation.

There are five different factors in adjusting the apparatus, namely:—The speed of the drum; the speed of the water; the grip of the vanes on the water, varied by moving them towards or away from the drum; the thickness of the wall of water; and the rate of flow through the drum which varies during the time which the material is being acted upon. This adjustment when once made for the particular material to be treated requires no further skilled attention.

The apparatus should obtain a recovery of 95 to 97 per cent of the metallic content of an ore, and, in addition, treat ores which have previously defied mechanical treatment. The separator will run at a power cost of considerably less than one penny per hour and is capable of treating at least two tons of ore per hour.



THE NEW CUNARD LINER "LACONIA"

The Engineer

A NOTABLE addition to the fleet of the Cunard Line is represented in the steamship *Laconia*, which left the Mersey on January 20th, on her maiden voyage to New York. This vessel was launched on the 27th of last July at the Wallsend-on-Tyne shipyard, and is the second largest vessel launched in England last year.

Although not nearly so large in point of gross tonnage, nor built with the object of attaining the unrivalled speed of either the *Mauretania* or the *Lusitania*, yet the *Laconia* embodies sufficient features, especially in regard to its passenger accommodations, to enable it to take place in the front rank of modern Transatlantic steamships. Both the *Laconia* and its sister ship, the *Franconia*, may be described as liners of the "in-

termediate" class, as distinct from an express or high-speed ship like the *Mauretania*, or slower vessels like the *Ivernia*.

Upon her return from New York the *Laconia* will proceed to the Mediterranean, and following this will take her place with the *Franconia* in the regular Liverpool, Queenstown and Boston service, being due to make her first trip from the Mersey to Boston on April 16th next. The leading dimensions of the new steamship are:—Length overall, 625 feet; breadth overall, 72 feet; depth from top of houses to keel, 90 feet; gross tonnage, 18,150 tons; displacement, 25,000 tons; height of funnels above lowest furnace bars 140 feet; diameter of funnels, 17 feet 6 inches, and height of masts, 200 feet above the keel.

The *Laconia* is fitted with two propellers, each consisting of four manganese bronze blades secured to a cast steel boss. Each propeller is driven by a four-crank quadruple-expansion engine having cylinders 33 inches, 47 inches, 67 inches, and 95 inches diameter respectively, with a stroke of 60 inches. Piston valves are fitted on the high-pressure, first and second intermediate-pressure cylinders, the low-pressure valve having an assistant cylinder. Both the engines are dynamically balanced on the Yarrow, Schlick, and Tweedy system. Steam is supplied by six large double-ended boilers having eight furnaces working under natural draught, the smoke being discharged through two funnels. The boilers are placed in two water-tight compartments. The stokeholds are large and cool, ample mechanical ventilation having been provided, in addition to the natural supply of air down the trunks, which are fitted with large cowl heads.

To facilitate overhauling and repairs of the machinery, a workshop is provided adjacent to the engine-room, and this is replete with various machine tools. The ashes and clinkers from the furnaces will be discharged either through the ship's side by means of Crompton's atmospheric hoists or through the bottom of the ship below the water-line by means of Stone-Lloyd expellers. The electric installation consists of three engines and dynamos supplying current not only for lighting the ship throughout, but also for a variety of other purposes, such as operating ventilating fans, culinary appliances, hoists, steam whistles, etc.

The *Laconia* is fitted with Marconi wireless telegraphy and submarine signalling apparatus, while a system of water-tight compartments extends the entire length of the ship.

The *Laconia* is the first British steamship to be fitted with the Frahm anti-rolling tanks, although the system has been in successful use for several months by the Hamburg-Amerika Line on its steamers, the *Corcovado* and the *Ypiranga*, trading between Hamburg, Southampton, and Cuba and Mexico, and the steamship *Victoria Luise*, running between Hamburg, Southampton and New York.

Briefly, this invention of Herr Frahm consists of two water tanks divided into compartments placed amidships on each side of the ship, connected across the vessel at the top by air trunks, and at the bottom by specially constructed water passages. In the *Laconia* the tank is situated in the foremost thwartship bunkers, and extends over fifteen frames. This involved no interference with the arrangement of the ship. By means of a water-tight cross bulkhead the tank is divided into two unequal and absolutely independent compartments, the after part extending over nine and the forward part over six frames. The lateral basins are not water-tight at the bottom; consequently the bilge is also filled as soon as the anti-rolling device is filled with water by pumps. The tanks are partially filled with water, and the movement of the ship is checked by the water flowing from one side to the other through the passages. To provide for changes in the movement of the vessel, the water, which is always under absolute control, in the tanks can be regulated according to circumstances. One or two compartments can be used as required by opening or closing valves fixed in the air trunks. By completely closing the valves, the passage of air from one side of the ship to the other is prevented, and the water in the tanks is thus maintained practically motionless.

THE EVOLUTION OF THE TURBINE PUMP

ESPECIALLY A HISTORY OF THE DEVELOPMENT OF THE REYNOLDS PUMP

E. Hopkinson and A. E. L. Chorlton—Institution of Mechanical Engineers

IN no domain, possibly, has the turbine rotary principle achieved greater success in the last few years than that of high-lift pumping. Though the realisation of its possibilities for such duties is perhaps as old or older than the steam turbine itself, still its general acceptance as correct engineering practice is only a matter of the last five years. At the present time the use of the turbine pump has become so extended that it is difficult to find services to which it cannot be applied.

In the year 1875 Professor Osborne Reynolds invented a turbine pump of the series type, fitted with guide vanes, the essential features of which have been adopted in subsequent practice. In this pump the impeller delivered its water to tangent guide vanes, in a manner similar to the inward-flow turbine of the Thomson type, inasmuch as the mouths of the guide-channels could be regulated to raise the efficiency of the pump for smaller outputs, a device which is rarely followed in later practice.

Nothing of any commercial value appears to have been done with the invention for many years; in fact, the first pump of which records and tests are available was constructed 12 years later by the firm of Mather and Platt for the Engineering Laboratory of the Owens College, Manchester. This pump had four impellers in series and gave a head of 148 feet at 1500 revolutions per minute.

The tests of Professor Reynolds proved the capability of the pump to perform many duties previously thought impossible by centrifugal pumps, hence in 1893 the firm of Mather and Platt took up its commercial manufacture.

The mechanical construction of a standard Mather-Reynolds pump as

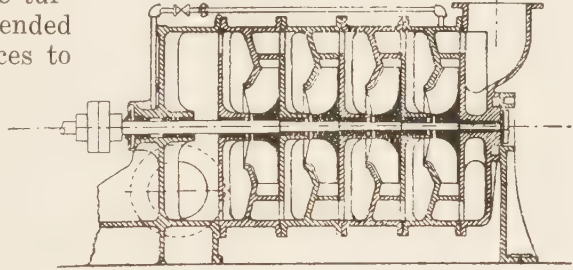


FIG. 1. MATHER-REYNOLDS PUMP, 1895

built in 1895 is illustrated in longitudinal section in Figure 1. It consists of four chambers working in series. At the one end these are secured by bolts against the circular flange of a frame carrying the shaft coupling, this flange having the suction branch and entrance to the first chamber cast with it. At the other end the delivery chamber forms the final cover and has the delivery pipe cast on the upper part connecting to the annular space into which the last set of guide passages deliver. This forms an inexpensive design and permits of accurate manufacture. It allows of chambers being added or subtracted for higher or lower heads. Each chamber is distinct in itself, and has on one side the guide-vanes, receiv-

ing the discharge from the impeller, and on the other the return passage to the eye of the next impeller. This return passage is walled by a diaphragm integral with the casting. The water leaving the impeller, guided by the delivery vanes, passes to the next chamber and is there guided to the eye of the following impeller.

In comparing such a pump with a modern one it will be found that it

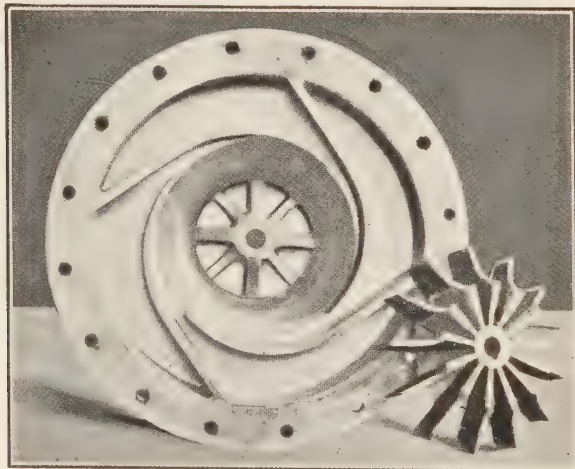


FIG. 2. IMPELLER AND GUIDE-PASSAGES, 1895 PUMP

is in the form of its impeller and its delivery casing that the original Mather-Reynolds pump differed most from the present design. The impeller as shown in the photograph, Figure 2, is of the open type (not shrouded), with radial vanes, the roots of which are carried across the openings of the eye into the boss, necessitating the use of a modified form of Francis entrance. The reasons that induced Professor Reynolds to adopt such a radial impeller are not quite clear, as the shrouded form with curved back blades was in common use at that time, and is a more efficient and stronger type.

A considerable number of pumps of the 1895 form were constructed for installations in England and

other countries. Meanwhile, Sulzer Bros., of Winterthur, had commenced the manufacture of multiple turbine pumps about the year 1896, and had evolved various modifications of the Reynolds design, and had considerably improved both the efficiency and lifting capacity. They had established in 1898 an interesting and novel installation of these improved pumps at the Spanish mines of Horcajo, which attracted much attention.

A four-chamber pump of the Sulzer design compared with the 1895 design shows three important differences. First, the body casting of the pump is constructed in one piece, with the intermediate pieces, guide-vanes, and impellers put in from one end. Second, the impellers are shrouded and have backward-curved vanes. And, third, the impellers are arranged back to back to compensate for the increased lateral end pressure set up by the higher heads worked against.

A four-chamber pump of later design is shown in longitudinal section in Figure 3. Constructionally this pump differs principally in that the extended suction-end is shortened, and is similar to the delivery-end. This enables various classes of drives, motor, belt, or steam-turbine, to be better negotiated with a standard pattern. Successive chambers, instead of being secured to their neighbours by bolts and flanges, are held together by long bolts extending the entire length of the pump body and held only at the two ends (suction and delivery). This construction secures among other things some economy in manufacture.

The impeller is of the shrouded type, having vanes bent well back-

wards and the guide-passages are longer and more correctly divergent, while the return-way to the eye of the next impeller is of a curved form and more in line and continuous with

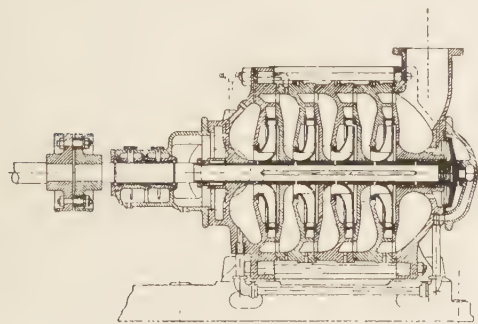


FIG. 3. MODERN FOUR-CHAMBER PUMP

the receptive ports, thus preventing the abrupt right-angle turn through the casing obtaining in the Reynolds pump. The losses in the Reynolds impeller through side friction in its casing are obviated, and any leakage

from the periphery back to the suction is prevented or greatly minimized by the outer circumference of the impeller eye running in neck bushes with a very small radial clearance, amounting to less than 0.005 inch. The importance of preventing this leakage is very great if high efficiency is to be secured. The impeller is turned all over outside to reduce loss by skin friction, and with the same object it is usual to use as many wheels as the circumstances will otherwise allow of.

The end or axial balance of the impellers is obtained by the automatic device shown, which acts well in practice, and compensates for wear and variable leakage taking place in the pump. In other respects the arrangement, direction of flow of water, and assemblage of the pump are the same as in the original Mather-Reynolds pump.

THE PRODUCTION OF SOUND STEEL INGOTS

THE HADFIELD PROCESS FOR AVOIDING SEGREGATION, BLOWHOLES AND PIPING

Sir Robert A. Hadfield—The Iron Age

NUMEROUS devices, both simple and complicated, have been devised, from time to time, for producing sound steel free from all defects, and have given more or less satisfactory results. In the majority of systems evolved, however, there has been some disadvantage which has barred it from extensive use, the chief of which has been the expense of application owing to the heavy cost of necessary apparatus.

The method to be described has been thoroughly tested by the author at the works of the Hadfield Steel Foundry Company, Ltd., and has enabled sound steel to be produced free from segregation, blowholes or piping, with little expense and high

efficiency. Moreover, not only is soundness obtained, but also fully 93 per cent of the fluid steel in the mold is made utilizable.

The method of carrying out the Hadfield process is shown by the accompanying Figure 1. As will be seen, this consists in heating the metal in the upper part of an ingot or other mold and maintaining it in a liquid condition by the combustion in contact therewith, or in close proximity thereto, during the cooling and shrinkage of the metal in the lower part of the mold, of solid fuel—for example, charcoal—by means of a blast of compressed air which is caused to impinge on the fuel while the fuel is directly or indirectly sup-

ported by the metal below; also the interposition of a layer of fusible material, such as iron slag, which has no injurious action on the metal, between the metal and the fuel.

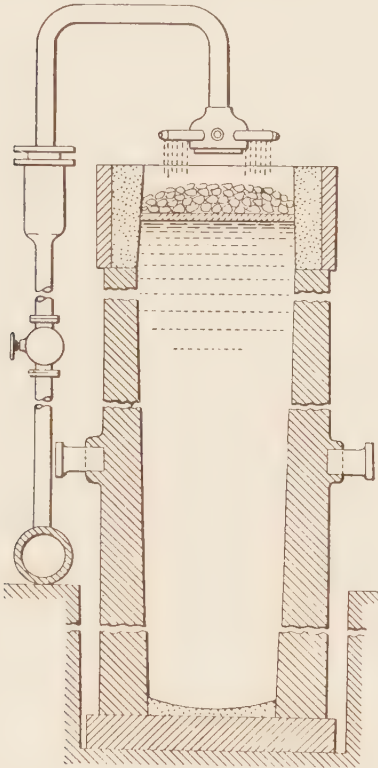


FIG. 1. HADFIELD INGOT MOLD

The cost of carrying out the method is trifling compared with the large saving gained in reducing loss and waste material. Moreover, the quality of the product is improved; for example, in making rails produced from such ingots, not only would there be less discard but the material would be sounder. During the last few years many thousand tons of ingots have been made by this patented process, which has been found of great advantage for work of this nature.

Figure 2 shows the results of this patent method as carried out upon ingots weighing about two tons each.

The system can be applied equally well to either smaller or larger ingots, for all kinds of purposes. It is estimated that on a large output the saving by this method would be from \$2 to \$3 per ton. Thus, on a large tonnage of hundreds of thousands of tons annually there would be a very considerable saving each year, as well as obtaining sound ingots free from blowholes, piping and segregation.

The following is a description of the ingots shown in Figure 2. The sand "head" was 14 inches square where it joined the ingot, tapering to 9 inches square in a length of 16 inches. The steel was filled up in the sinking head to a depth of 14 inches, the remaining 2 inches of the sand head being filled with a layer of ground slag, having a thickness of about $1\frac{1}{2}$ inches. The slag was put on the molten steel, then the heating carried out by means of the charcoal and blast. The head was afterward

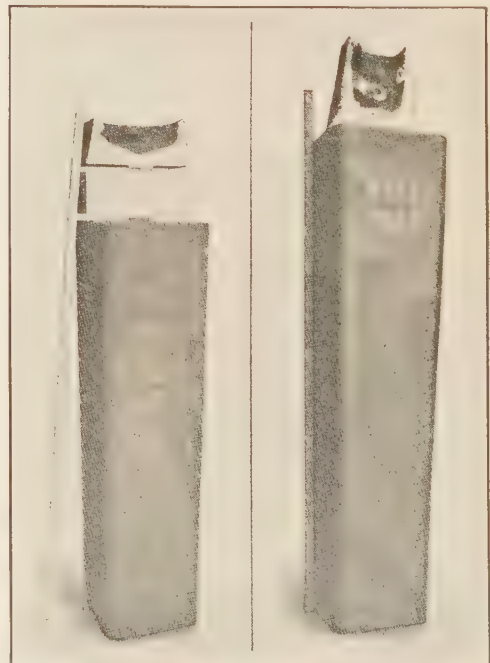


FIG. 2. INGOTS TREATED BY THE HADFIELD PROCESS

cut off the ingot, and was found to be free from piping or segregation. Following are the details: Total weight of ingot, 4,300 pounds; weight of sand head, 290 pounds; weight of ingot produced, 4,050 pounds. This is equal to a waste of about 6.7 per cent.

As will be seen from Figure 2, the steel has "fed" well, practically the whole of the molten steel in the head having descended bodily to feed the cooling shrinkage of the ingot.

The head was drilled and analyzed to find if there was segregation. The results are shown in the table below. It will be seen that even C is almost normal in its composition, and D, a little lower down, has practically the same analysis as the bulk of the ingot. The original analysis in this heat, as shown by the test ingot, was: Carbon, 0.50; silicon, 0.16; sul-

phur, 0.033; phosphorus, 0.037; manganese, 0.80.

Position of test piece.	Car- bon.	Sul- phur.	Phos- phorus.
A—1 in. below head...	1.41	0.175	0.135
B—2 in. below head...	1.20	0.12	0.10
C—3½ in. below head.	0.59	0.041	0.041
D—Ingot itself.....	0.50	0.033	0.037

This ingot, with the sinking head described, is a still further advance in the improvements effected in this matter, the segregation being very slight. It would appear that 93 per cent of this ingot may be utilized for commercial purposes.

In experiments made with mild and ordinary steel it was found that, with the exception of 8.8 and 7.9 per cent waste, respectively, practically the whole of the remaining portion of the ingots represented salable and serviceable billets. The same results may be obtained with either small or large ingots.

HEAT PATHS IN ELECTRICAL MACHINERY

DATA ON THE HEAT CONDUCTIVITY OF ELECTRIC INSULATING MATERIALS

H. D. Symons and Miles Walker—Institution of Electrical Engineers.

IN order to get the largest possible output from an electrical generator or motor of given cost a very close study must be made of the possible methods of carrying away the heat which is produced in the iron and copper. These metals being good conductors, any heat produced in them distributes itself over the whole mass, but the insulating materials being poor heat conductors often cause excessive temperatures within the coils which are enclosed by them.

To obtain specific data on the difference of temperature a designer might expect between any two points in the heat paths of electric machines, the authors carried out a number of tests on the conductivity

of the commonly employed insulating materials.

The method of carrying out such a test is described as follows: The material is wrapped around a copper cylinder, thermo-couples used for measuring the temperature of the outside are then fixed and wrapped over with an exterior copper sheet, the insulation is trimmed off the ends of the cylinder so as to fit well against leather washers, and two wooden cheeks are fitted to the end of the cylinder and held firmly by long bolts. The whole is then immersed in an oil tank and the wires to the various couples connected to a multiway switch and to a cold thermo-couple immersed in a bath of oil whose temperature is kept steady

and measured by means of a thermometer. A known current at a known voltage is then passed through the resistance coil inside the copper tube, and the temperature of the oil in the bath is raised to the point at which it will remain steady under the conditions of the experiment. Readings of the temperature are taken at frequent intervals, and when they are found to be steady it is known that the heat is being conducted through the insulation at the same rate as it is being supplied. The total heat flow through a certain area and thickness of insulation being known, and the difference of temperature at the two sides being known, the thermo conductivity can be calculated.

In other experiments the copper tube and insulation were placed in a wooden frame by means of which two draughts of air could be blown on to the material under test from opposite sides. The intensity of the draught of air was measured by means of anemometer and checked by measurements of the temperature of the air going in and the air coming out. This apparatus, besides giving measurements of the heat conductivity of insulation, gives also specific data for the cooling of surfaces when subjected to a draught of this kind under conditions somewhat resembling the conditions obtaining in some electrical machines.

It was found that all the cellulose materials such as cotton, paper, etc., had a considerable temperature coefficient. The heat conductivity at a temperature of 100° being about 12% higher than at 30° C. The heat conductivity of mica was not found to change between 20° and 100° C. Of all the fibrous materials commonly used in insulation the one having the highest thermal conductivity is empire cloth pressed into a solid mass free from air-spaces. This is prob-

ably because the fibres of the empire cloth are completely filled with oxidised varnish, whereas many of the papers, even when closely compressed, contain air-spaces. The difference in the conductivity obtained by winding the insulation on the copper cylinder very tightly and by winding it loosely was very marked.

Very often a field coil insulated on the inside with layers of insulating material does not fit tight upon the pole, so that a short air-space exists between the insulation and the iron of the pole. A number of experiments were made, in which air-spaces of different thicknesses were made between the copper tube in the testing apparatus and the insulating tube. These spaces were made by winding twine of different thicknesses in a wide spiral round the tube, and then winding the insulating material above the spiral. The thickness of the twine gave approximately the size of the air-space. It is to be expected that a very narrow air-space will have a greater thermal resistance per centimetre of thickness than a wider air-space, and as the space is widened out we come at last to a constant resistance (for 1 sq. cm. area of surface) which is the reciprocal of the cooling constant ($h = 0.0011$) for surfaces exposed to still air.

It sometimes happens that the copper conductors on an armature or field magnet are grouped together so closely that very little air can circulate between them, and the total cooling surface of the group is too small to dissipate the heat generated in it. In this case one relies mainly for cooling upon the conduction of heat along the conductors to parts of the coils where the cooling conditions are better.

There are three main cases occurring in electrical machinery in which

it is necessary to calculate the rate of convection of heat from a solid surface to the surrounding air. (1) An armature or field magnet of approximately cylindrical shape revolving within the stationary part of the machine. (2) A field coil against which a draught of air is blowing. (3) The iron surface of a ventilating duct, through which the air is passing at a certain velocity.

The laws of cooling of the solid surface are different in the three cases. The first case is very complicated. A formula for the close predetermination of temperatures would have to take into account, not only the square inches per watt and the peripheral speed, but also the length of the air gap, the temperature and shape of the surrounding objects, as well as of the air, the nature of the cooling surface, and the rate at which the air in the gap is changed by artificial ventilation so produced.

In predetermining the temperature rise of a wire-wound coil, the temperature rise of the external and internal surfaces of the coil must first be found. These will be the temperatures at which the coil can dissipate to the surrounding medium all the heat generated within it. In the next place the rise of temperature of the hottest part above the external surface must be determined by taking into account the heat conductivity of the layers of insulated wire and the watts per cubic centimetre generated within the coil. Some designers make their shunt coils to be entirely air cooled. They provide such large air ducts between the coils and the poles that all heat passes to the air. Other designers make the coils a tight fit on the poles, and rely upon conduction of a large portion of the heat generated through the insulation to the body of the pole, whence it

passes to the frame, or is dissipated from the pole-face.

To provide sufficient cooling surface so that the heat may be communicated to the air and carried away by it, there are really two matters involved; one is the provision of sufficient air to carry away the heat produced, and the other is the provision of cooling surface exposed in such a way as to heat up the air which passes through the machine.

For cooling large machines, such as turbo-generators, there are two general methods of providing paths for the air. According to one method, the air is passed through axial holes both in the rotor and in the stator, and it is the internal surface of these axial holes which mainly constitutes the surface exposed. Sometimes the air is passed from both sides of the machine towards the middle, and in other cases the air is passed from one end of the machine to the other. According to the second method the air is passed through a spider or through axial holes in the rotor, and thrown out through radial ducts in the rotor to radial ducts in the stator.

In cases where one cannot get rid of all the heat from the cylindrical surface of the armature and where it is therefore necessary to provide further cooling surface a radial ventilating duct is very effective. It enables an exceedingly large surface to be provided without unduly increasing the cost of the machine. In general it may be said that in the cooling of large electrical machines the following matters must be taken into account:—

Sufficient air must be provided to carry away the heat generated. If 100 cubic feet of air per minute is provided for each kilowatt loss it will in general be sufficient. If the conductivity for heating of all parts is

sufficiently good and the air is so distributed that none of it receives a temperature rise greater than 32° C. it may be that 60 cubic feet of air per minute would be sufficient to keep the machine below 45° C. rise.

Sufficient cooling surface must be provided to communicate the heat to the air.

For ventilating ducts we may take the formula— $h_v = 0.0014 v$.

Where h_v is the watts per square centimetre of cooling surface per degree centigrade the difference of temperature between surface and air and v is the mean velocity of the air in the duct and metres per second.

For the cooling of the surface of rotors and the internal cylindrical face of stators we may take the formula— $t^{\circ} = \frac{333 \times \text{watts per sq. cm.}}{(1 + 0.1 v)}$

UPLIFT AND ICE PRESSURE IN MASONRY DAMS

EXPRESSION OF OPINION IN VIEW OF THE RECENT AUSTIN DAM FAILURE

Edward Wegmann—Proceedings American Society of Civil Engineers

THE questions connected with the design of masonry dams, as mentioned in a paper by C. L. Harrison presented before the American Society of Civil Engineers, are of great importance. This paper indicated the conclusion at which one should arrive with reference to upward water pressure under the base of a dam in designing the profiles, namely, that it would depend on the rock on which the dam was to be founded. In some cases there might be considerable upward pressure, while in others, little, if any allowance should be made for such a force.

The French engineer, De Sazilly, in 1853, explained for the first time, the principles on which the design of a masonry dam should be based. His theory was that, in order to be safe, the structure should have a sufficient factor of safety against overturning and sliding, and that the maximum pressure to which the masonry and foundation were to be exposed should not exceed a safe limit. As far as the last element of strength is concerned, his ideal type of dam was one in which the maximum pressures in the masonry, at different levels, were exactly equal to the highest allowable amount.

Other French engineers proposed profiles somewhat different from De Sazilly's type, and Professor Rankine added to their requirements the important condition that the lines of pressure, for reservoir full or empty, should be kept within the centre third of the profile, in order to avoid tension in the masonry; and he also pointed out that the assumed limit of vertical pressure should be lower at the downstream face than at the upstream face.

None of these engineers took into account either upward pressure under the base of the dam or ice pressure, and, although a great many dams have been built according to their types, none have failed, with the exception of one in France, built on a bad foundation, and another in Africa, constructed in a very defective manner.

In 1884 the engineers of the Aqueduct Commission of the City of New York had to design a masonry dam, from 275 to 300 feet high, which was to be built across the Croton River, near its mouth, to form a large storage reservoir for the water supply of that city. The site originally selected for the proposed dam was at the Old Quaker Bridge, about 4 miles

above the mouth of the river, and, because of this location, it was called the Quaker Bridge Dam. The structure was eventually built, in 1892 to 1907, $1\frac{1}{4}$ miles farther up stream, and was named the New Croton Dam, in contradistinction to the Old Croton Dam, 3 miles farther up stream.

At the time the New Croton Dam was being designed, in 1884, the highest reservoir wall in existence was the famous Furens Dam, in France, which had a maximum height of about 184 feet above the foundation. In America there was only one masonry dam of any height, namely the Boyd's Corners Dam, across the West Branch of the Croton, having a maximum height of 78 feet above the foundation.

The formulas for determining the proper profile of a masonry dam, which had been published up to that time, were very complicated and unsatisfactory. They required that the maximum pressure in the dam, at different levels, should be kept at a fixed limit of safety, which was taken at from 6 to 10 tons per square foot. Had such data been used in the design of the New Croton Dam, its downstream face would have become almost horizontal at a depth of 300 feet. A higher limit for the permissible pressure in the masonry and on the foundation was assumed, and was fixed by the engineers of the Aqueduct Commission at 16 tons per square foot. The designers were confirmed in the reasonableness of this assumption not only by tests on the crushing strength of masonry, but by the fact that the Almanza Dam, built in Spain prior to 1586, was sustaining a pressure of about 14 tons per square foot.

The possibility of an upward pressure under the base of the dam was considered carefully by the engineers, but calculations for such a force were left out of consideration

on the ground that with the depth to which the foundation was to be carried and the care contemplated in closing all fissures and seams in the rocks, an upward pressure, if it occurred at all, would in all probability extend over only a very small part of the base. While the Board of Experts advised that the dam be curved in plan, and that it be designed to resist an ice thrust of 43,000 pounds per lineal foot, yet these suggestions were disregarded, and the dam was built straight in plan and with no consideration for either upward pressure or ice thrust.

The Wachusett Dam, built in Massachusetts in 1900 to 1906, was the first American dam in the design of which an upward pressure under the base was taken into account. In this case there was a town of 13,000 inhabitants about half a mile below the site, and failure would have caused a great disaster. Under these circumstances, the engineers adopted a very strong profile, calculated to resist an upward pressure under the base equal to two-thirds of the pressure of the water at the up-stream face and diminishing uniformly to zero at the down-stream toe, and, also, an ice pressure of 47,000 lb. per lin. ft. of dam at the highest ice line.

In the Cross River and Croton Falls Dams, built recently in the Croton water-shed, the designs were based on similar conditions, an upward pressure under the base being calculated in the same manner as for the Wachusett Dam, but the ice pressure per linear foot was taken at only 24,000 lb. for the Cross River Dam, and at 30,000 lb. for the Croton Falls Dam. These structures are near the New Croton Reservoir, no habitations being directly below them, and under these circumstances it is a debatable question whether the profiles should have been made as strong as they were.

There have been three cases of failures in masonry dams on record, in which upward pressure under the base of the structure doubtless played a large part. They were all built on poor foundations. The Bouzey Dam was founded on red sandstone, which was fissured and quite permeable. The foundation for the dam itself was only excavated to fairly good bottom, and not to solid rock. The first time the reservoir was filled, a portion of the dam was shoved forward so as to form a curve.

Part of the foundation of the dam at Austin, Texas, was on a fault, filled with adobe with an occasional streak of red clay. The foundation trench was not deep enough, and protection against erosion was insufficient. The failure of the dam at Austin, Pennsylvania, is so recent that it need not be described. The dam was founded on sandstone, underlaid by shale having fissures filled with clay, sand and gravel.

From these facts, the conclusion may be drawn that uplift under a dam may vary from nothing to a considerable force. How much upward pressure should be assumed in any given case is purely a matter of judgment. When uplift under the base of a dam is considered in designing the profile, provision is usually made for it at any level above the base, as the same profile is generally used for the highest parts of the dam and for the low parts at the two ends. For this reason the profile would be designed so that, when the base was taken at any level below the top of the dam, the masonry above the base would have ample strength to resist the thrust of the water on its upstream face and, also, the assumed upward pressure under its base.

The question as to how much should be allowed in northern latitudes for ice pressure against a ma-

sonry dam is difficult to answer with the information now available. Ice, when confined, as between two bridge piers, doubtless exerts great pressure in expanding, but when this ice is in a reservoir having sloping banks, the dam being usually in a narrow gorge, it is doubtful whether it would exert much pressure against the dam.

It is certain that, if the great uplift and ice pressure which some engineers recommend had been realized, many masonry dams, now standing successfully, would have been ruptured long ago.

The writer has tested by calculation the strength of some American and foreign dams to withstand a full upward pressure under their bases, and an ice pressure of 25 tons per lineal foot, an assumption which some engineers think should be made in designing, and has found the lines of pressure, reservoir full, to fall for a great part outside of the profile. In such a case a dam would be overturned unless this were prevented by the tensile strength of the masonry. The writer is satisfied that such a condition does not exist in the dams to which he refers.

If ample security against failure were all that the engineer had to seek in designing a dam, his task would be very easy. He might follow the simple rule of making the width of the dam, at any level, equal to one and one-half times the height, and feel sure that nothing short of an earthquake would cause rupture. There remains, however, the consideration of cost, and the best engineer is he who obtains the required security and architectural appearance of the dam, at the least expense. The engineer who combines, with his theoretical knowledge, sound judgment and courage to follow his convictions, is the ideal type which all should strive to follow.

THE TIRRILL REGULATOR

AN ACCOUNT OF ITS PARTICULAR APPLICATION ON THE MERSEY RAILWAY

Engineering

THE Tirrill regulator is intended for automatically controlling the voltage regulation of either alternating or direct-current generators, and may be connected up to maintain a constant voltage on bus-bars or at the centre point of a distributing network, compounding for line drop. It is also applicable in connection with reversible boosters, flywheel motor-generators, etc. The action of the regulator depends, in principle, on the intermittent short-circuiting of a rheostat which controls the field, and consequently the voltage of an exciter, or exciters, supplying the field current to the machine, or machines, the voltage of which has to be controlled. By intermittently short-circuiting the rheostat, which is in series with the field, it is possible to obtain a field flux in the exciter which is intermediate between the flux obtained with no resistance in circuit and that obtained with all resistance in circuit. Further, the effective field flux may be varied by varying the rate at which the rheostat is short-circuited, so that the system allows of a complete control of the field of the exciter over the range for which the instrument is set. The great advantage of the system of control lies in the rapidity with which the instrument may be made to respond to voltage variations in the circuit which is being controlled. This rapidity is made possible by the fact that, owing to the short-circuiting system of control, the whole of the movements which have to be made are of small dimensions,

so that they may be carried out with extreme rapidity. Further, the moving parts are very light, so that there is no delay owing to their inertia when they have to be set in motion.

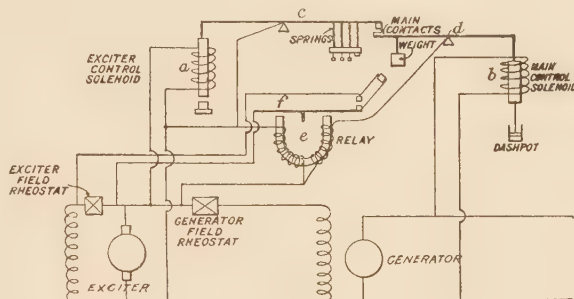


FIG. 1

A simplified diagram, showing the essence of the regulator, but divorced from any subsidiary circuits, is given in Figure 1, above. This diagram shows the connections for the control of a direct-current generator, but the arrangement is essentially the same when the regulator is applied to an alternator. The apparatus consists of two solenoids *a* and *b*, each with a moving core suspended at the end of a horizontal pivoted lever. The two levers are shown at *c* and *d* in the figure. The pull of the solenoid *a* on the lever *c* is balanced by four spiral springs, while that of the solenoid *b* on lever *d* is balanced by a fixed weight, as shown. The solenoid *b* is so designed and adjusted that the pull for any given voltage remains constant irrespective of the position of the moving core within its working limits. The movement of the moving core is damped by a dashpot. The two levers *c* and *d* carry a pair of main contacts at their inner

ends, which are closed together or opened during the operation of the regulator. In addition to the two solenoids, the apparatus contains a relay shown at *e*. This has two coils, one of which is connected permanently across the exciter brushes, and the other across the same brushes, but through the contact-blocks which are carried at the ends of the pivoted levers. The two coils are wound so that they oppose each other. The relay controls by attraction a pivoted lever, the movement of which opens or closes the short-circuit contacts of the exciter field rheostat. This lever, which is shown at *f* in the figure, is fitted with a spiral spring which tends to hold it away from the relay and to close the short-circuit contacts.

The operation of the regulator may best be followed by assuming a change in load on the generator, and tracing through the operation of the various parts. If it be supposed, for instance, that a sudden load comes on the generator so that the volts have a falling tendency, the result will be that the flux in solenoid *b* will become less, and that the moving core will move downwards, closing the main contacts. As soon as this occurs the right-hand coil of the relay will become magnetised, and neutralise the left-hand one, so that the lever *f*, which previously was held down by the relay, will be released, and under the action of its spring will close the short-circuit contacts of the exciter field rheostat. The instant this happens the voltage of the exciter will rise, and increasing the flux in solenoid *a*, will cause the lever *c* to move in a counter-clockwise direction, tending to open the main contacts. As, however, the lever *d* will be at the same time moving in a clockwise direction, the contacts will remain closed until the exciter voltage rises

to such a value as to maintain such field on the generator as will give the voltage for which the regulator is set. As soon as the generator voltage attains the correct value the arm *d* finds itself in a position of equilibrium, and ceases to move, the arm *c* meanwhile continuing to rotate until the main contacts are parted. When this occurs the relay *e* becomes magnetised again from its left-hand coil, owing to the breaking of circuit on its right-hand one, and pulls down the lever *f*, opening the short-circuit on the exciter-field rheostat, thus causing the exciter volts to fall. When, however, they have fallen but the slightest amount, the pull of the solenoid *a* is weakened, so that the lever *c* moves in a clockwise direction, and closes the main contacts again.

The regulator, among various other duties, in conjunction with a motor-generator has been installed to supply lighting current to the power house of the Mersey Railway at Liverpool. The new motor-generator replaces a separately steam-driven generator which previously supplied the lighting circuits. This installation has resulted in a saving of £500 a year. When it is stated that the traction supply voltage varies from 550 to 720 volts it will be seen that the service demanded from the new installation was somewhat onerous.

The new arrangement consists of a 205 horse-power motor connected to the 550-720 volt mains, and has mounted on its same shaft a 134-kilowatt 690-volt generator and a small exciter. The regulator acts on the rheostat of the exciter in the manner previously described, and so controls the field of the generator. Owing to the great variation of the supply voltage an additional relay is fitted to the regulator, the contacts of which open when the other relay contacts close, and the reverse. These

additional contacts are connected across the motor-field rheostat, so that the motor-field is increased or decreased when the exciter-field is decreased or increased. The result is that as the exciter and generator-fields are being strengthened to increase the voltage, or weaken to de-

crease it, the motor-field is being weakened to prevent the field from falling or to increase the speed as the case may be. Condensers at the lower part of the regulator are inserted for the purpose of preventing a spark when the short-circuiting contacts of the field rheostats are opened.

SAPPHIRE CUTTING TOOLS

THE APPLICATION OF THIS MEDIUM IN PLACE OF DIAMOND FOR ABRASIVES

Herbert L. Thompson—American Machinist

MOST mechanics accustomed to fine work are familiar with the use of diamond as an abrasive and a cutting tool, but few know that the sapphire, while much softer and cheaper, will perform almost equal service if properly used.

The process of grinding diamond to a cutting edge is an extremely slow and costly undertaking, and even with its great hardness some of the most desirable shapes are impracticable. While much harder, it is scarcely less brittle than sapphire, and, if chipped or dulled, regrinding is a matter of hours, but a fairly large sapphire tool may be ground within a few minutes. A soft steel or copper lap charged with diamond dust will cut sapphire as rapidly as it would steel, and, further, any reasonable shape may be produced.

It is often desirable to finish the outside of small round steel parts after hardening, to insure absolute accuracy and truth, and where there are no shoulders nor intricate shapes, grinding answers all purposes, but as it is only the plainest shapes that can be ground, it is customary either to trust to luck in hardening or make a clumsy-looking piece to facilitate grinding. Watch balance staffs, pinions, jewel settings, screws and arbors, small punches, tappers, dowel

pins, hardened lathe centers, and in short, almost any kind of small work can be finished with sapphire.

A sapphire tool correctly shaped and polished will cut absolutely glass-hard steel, smoothly and rapidly, and will produce a chip that will curl into a beautifully burnished helix, tough enough to hold together for a length of several inches. The tool would have to be in bad shape before producing the powdered chip so common with the diamond tool when turning hardened steel.

It is possible to force sapphire on hardened steel, until the chips come off blue, but it will generally result in a chipped tool edge before long. A piece of hardened steel must be round and fairly true in order to turn well with sapphire, and if there are transverse holes or flutes in the piece, they are likely to break the tool edge if not very carefully handled. A chipped edge on a sapphire tool is not such a serious thing, however, as it can be reground almost as easily as a steel tool can.

The shape of a sapphire tool is probably the most important factor contributing to its efficiency for cutting metal; it must be very different from the shape of a steel tool for the same purpose. Most important of all, the clearance on a sapphire tool

should be a curve, not an angle, if maximum service is expected, and the amount of clearance should be very small. A sapphire tool properly ground to turn the outside of a round piece of work appears altogether too blunt to cut at all. The top of the tool should be chamfered toward the edge just enough to insure against hogging; one or two degrees is sufficient, and both the chamfer and clearance must be polished as highly as possible.

For producing a fine finish on aluminum, hard rubber, fiber, brass, oroide, copper and gold, sapphire is unapproachable, as it will cut at a high surface speed and will not wear away as a steel tool does on hard rubber or fiber. For turning aluminum, kerosene should be used with the sapphire, but on steel either hard or soft, no lubricant seems to help, and oil prevents the proper bite of the tool. Gold, brass and oroide work much better if the sapphire is wet with saliva, for which there appears to be no substitute. For a particularly fine polish on the last named metals, the tool should be ground to the correct shape, highly polished, and fed into the work as a form tool. It will improve matters if the surface speed is very slow for the last three or four revolutions.

For securing a fine polish on the softer metals, very little stock should be removed with the sapphire; a roughing tool of steel to precede the sapphire and bring the work almost to size, being a necessity if much work is to be done. A heavy cut in soft metal does not hurt the sapphire, but it causes the metal to stick to the edge of the tool in a thin film which will spoil the polish. As many as ten thousand polishing cuts can be made on brass wire $\frac{1}{8}$ inch in diameter, at one grinding of the tool, provided that the surface speed is

slow, the cut light and the sapphire well lubricated with saliva. A surface speed of two feet a minute will give a beautiful polish on brass if the other conditions are right.

In grinding a sapphire tool, a disk of soft steel or copper charged with medium grade diamond dust makes an excellent lap. This lap should be well supplied with water in use, for if allowed to become dry, a chipped tool and a scored lap will result. The surface speed of the lap in grinding should be about 1250 feet per minute. In polishing the tool, a close-grained boxwood lap charged with the finest diamond dust to be procured is most desirable.

When changing from grinding to polishing laps, the tool should be carefully cleaned to remove any coarse diamond dust, but it must not be moved from its position or the polishing lap will not follow the same form that the grinding lap did. The least bit of coarse diamond on the polishing lap will cause it to scratch and spoil the polish, but the same care is altogether unnecessary with the grinding lap. The chamfer on the top of the tool is most easily made by hand on the polishing lap. It is not a very particular operation and will be found quite simple with a little practice.

A skilful workman can produce most of the desirable shapes for sapphire tools, by simply holding the tool against the lap by hand, but in manufacturing operations where the sapphire is probably most valuable, it is absolutely necessary to have some kind of a fixture to reproduce the shape. Especially where the sapphire is used for polishing it is necessary to be able to duplicate the shape of the tool absolutely, as the slightest change in clearance will cause a great difference in the surface secured.

LAND DRAINAGE BY PUMPING

A BRIEF RESUME OF THE MOST ADVANTAGEOUS AND ECONOMIC METHODS

S. M. Woodward—United States Department of Agriculture

DRAINAGE by means of pumps has been carried on in European countries for the last hundred years, and has been rapidly increasing in the United States during the last twenty-five years. Through such extensive experience, including numerous failures, a considerable amount of knowledge is now available on the subject of the proper arrangement and the requisite capacity of pumping plants.

Among the plantations along the Gulf of Mexico, pumping has been in vogue for a long period. In Illinois, although first tried about twenty years ago, little was accomplished prior to 1900, but by the spring of 1910 ten plants were in operation, covering a total area of about 85,000 acres. The greater part of the lowlands along the Illinois River have been already reclaimed in this manner, and, as the lands are in the heart of the corn belt and possess a heavy, rich black soil, their value has led to a greater activity in drainage reclamation in the immediate vicinity than has existed in most other portions of the country.

Before building levees and installing pumping machinery, it is necessary to have a considerable area included in a single project. Also, in order that the various landowners may work harmoniously together, it is necessary that they incorporate a drainage district according to the state laws, and appoint suitable officers to carry out the work of construction.

Such districts with as small an area as 3,000 acres may be profitably formed in favorable locations, but in

general the expense per acre is less if districts of about 10,000 acres are formed. This size appears to be the most satisfactory from all standpoints.

The boundaries of a district are determined by the natural surface conditions. A district will naturally include all the land on one side of the river between the channel and the bluff, and extend up and down the river from one tributary to the next of any size entering the river on the same side.

The protective levee begins at the bluff, follows along the bank of one entering tributary to its junction with the river, thence along the river bank to the other tributary, and up that again to the bluff. The correct location of the levee and its construction are engineering questions of vital importance. The height of the levee may vary from zero to 20 feet, but in general is from 8 to 12 feet. It should extend at least 3 feet above the highest expected high water. The side slopes should be at least 3 to 1 on the river side, and 2 to 1 on the land side, and the top width should be at least 6 feet. A tenacious clayey soil or gumbo is the best material for construction.

Excessive and injurious amounts of drainage water may enter a district from three sources: (1) Rainfall; (2) run-off from higher lands; and (3) seepage under the levee when the river is high. These factors must all be considered in the calculations for the determination of the size of the ditches, reservoirs, and pumps. Any water so accumulated must be collected in ditches and

led to some suitable spot near the levee where the pumps may lift it over the levee and discharge it into the river.

The size and arrangement of such ditches may be determined by the same hydraulic principles which govern any gravity system, with the essential difference that the ordinary ground-water level should be kept at least 3 feet below the surface of the lowest ground, if possible, to provide room for the root system of growing crops, and also as a margin of safety in case of breakdown or other cause. The main ditch and its branches should traverse the lowest areas of the district and follow subdivision lines wherever practicable.

The size of the pumping plant required for any particular district depends upon a variety of conditions, among which are the size and slope of the district and outlying districts; the available storage capacity in ditches and reservoirs; the system of interior drains; the nature of the soil and subsoil; the method of operating the pumping plant; the degree of drainage required by the crops; and the amount and distribution of the annual rainfall.

The annual cost of a pumping plant is made up of three main items: (1) The charge for interest on the original cost of the plant and for depreciation; (2) the cost of fuel; and (3) the cost of labour.

The majority of pumping plants installed along the Illinois and Upper Mississippi Rivers have been planned to have a maximum capacity sufficient to remove a quarter of an inch of water over the entire district in 24 hours. This is equivalent to 6.74 cubic feet per second per square mile, or 0.0105 cubic feet per second per acre. For cleared rolling pasture land or cultivated corn land it may be advisable to increase this quarter inch coefficient by 50 per cent. The

size of the pumping plant, however, may be considerably reduced if there are large storage reservoirs in the district, or if the plant is designed to operate night and day.

The centrifugal pump appears to be in most general use for these purposes. It is simple, has no valves, and can be obtained in all sizes. Its disadvantages are, however, that it must be primed in starting, can be operated only within a narrow range of speed, and its efficiency under practical conditions is not high. Rotary displacement pumps and plunger pumps have been occasionally used, but are not well adapted to this purpose. They may have high mechanical efficiency, but their cost more than offsets this advantage.

To remove a depth of one-fourth inch of water over a district of 10,000 acres in 24 hours will require a capacity of 105 cubic feet per second. For such a district it will be best to use two separate pumps, which should be identical in size. A 30-inch pump will be rated at about 49 cubic feet per second; a 32-inch pump at about 56 cubic feet per second; and a 36-inch pump at about 71 cubic feet per second. In this case it would be best to use two 32-inch pumps, which would seem to have a slight margin of excess capacity.

The pumping plant should be enclosed in a substantial and durable building. The foundations of the building, and especially of the machinery, should be prepared with great care. Usually the soil conditions are not good, so that piling must be driven under all the foundations for the machinery. The piling must be made ample to secure firm and rigid support for all the machinery so that there may be no subsequent settlement.

Proper arrangement of the suction and discharge pipes is very impor-

tant for the economical and reliable operation of the plant. All pipes should be as direct and straight as possible, and any bends should be of long radius to avoid any unnecessary loss due to friction.

The suction pit should be carried to a greater depth than the main canal, for the horizontal edge of the entrance to the suction pipe must be as low as the lowest level to which the water is to be reduced in the main ditch, and there should be also a clear distance between this edge and the pit bottom equal, at least, to the diameter of the suction pipe.

The annual cost of operation will depend upon how much water the pump raises during the year. Continuing the use of the same illustration as before, with liberal assumptions so as to be on the safe side, to remove during the year a depth of 1.5 feet of water over the district of 10,000 acres against an average static head of 16 feet will probably require 1,700 tons of coal, which, at a cost of \$2.50 per ton, would amount to \$4,250. One man might well be employed to take care of the plant throughout the year at \$100 a month; the expenditure for all other labor probably need not exceed \$800. This would make a total of \$2,000 per

year for labor. The total cost of operation, then, might approximate \$6,250, or about 60 cents per acre, which with the charge for interest and depreciation would make the total annual charge 90 cents per acre. This is a liberal estimate and in dry years would be much reduced.

The operation and supervision of the pumping machinery must be given careful attention with a view to securing the greatest economy in operation and careful preservation throughout the year. This requires the use of reliable skilled attendants. Full records of the operation of the plant should be maintained, as well as detailed classification of expenditures, so that those in charge may determine at all times whether the operation of the plant is the most economical that may be possible in securing the results desired from the plant.

Where practicable, gravity outlet sluiceways should be installed in connection with a pumping plant for use during times of low water outside of the drainage district.

When properly designed and operated drainage pumping plants prove highly profitable for the reclamation of wet lands in regions where agricultural land is sufficiently valuable.

THE SLOW-SPEED CHILEAN MILL

COMPARISONS WITH THE STAMP MILL FOR SERVICE IN MEXICO

J. B. Empson—The Engineering and Mining Journal

THERE are several claims to be made in favor of the chilean mill in Mexico as compared with stamps, especially in small installations. Arguments in favor of the latter are based, in general, on the following points; simplicity, ease with which repairs can be made, small space occupied, availability of men who are familiar with their op-

eration. There is much to be said in favor of stamps especially when considering ores which do not call for reduction in slime, but on which leaching of sand is possible. Under conditions where ore is to be crushed to $\frac{3}{4}$ -inch mesh in stamps and reduced to 30 or 40 mesh in tube mills, the slow-speed chilean mill does not compete.

The slow-speed chilean is essentially a fine grinder and as such can show a mechanical efficiency that cannot be obtained by stamps and tube mills. For this reason it is especially adaptable to Mexican conditions where the latest metallurgical practice is to grind silver ore so that not more than 20 per cent will remain on a 200-mesh screen. To do this work with stamps entails the installation of one tube mill to each five stamps when each stamp weighs 1250 pounds. Putting these at their maximum capacity of 10 tons per stamp according to Mexican practice gives results as follows:—10 stamps (1250 pounds each) at 100 drops per minute requires 27 horse-power or 2.7 horse-power per stamp. On a basis of 100 tons and deducting 10 tons for slime in batteries, the charge to each of two tube mills is 45 tons. Allowing two 5x16-foot tube mills to do this work, the rated running power required for each mill would be 46 horse-power. The total power required is, therefore, 119 horse-power or 1.19 per ton. To do the same work with slow-speed chilean mills would call for an installation of four mills requiring 15 horse-power each to crush about 25 tons per mill per 24 hours to an estimated degree of fineness as shown by the following figures:—On 60 mesh, 1.15%; on 80 mesh, 5.65%; on 100 mesh, 0.15%; on 200 mesh, 25.75%; through 200 mesh, 67.30%. This is stated to be an average result. Hence it is seen that in crushing 100 tons of ore by this method the amount to be reground is 34.75 tons of which only 8.95 tons can be classified as being coarse. To do this work would take one 4x16-foot tube mill using 27 horse-power at rated running, making a total of 87 horse-power for the whole installation equivalent to 0.87 per ton of ore crushed to 200 mesh. From the fig-

ures as given above it will be seen that with the chilean mill installation there is a saving of 0.32 horse-power per ton as compared with stamps and tube mills.

An interesting comparison recently made by W. H. Urbiter between stamps and tube mills and slow-speed chilean mills gives figures as follows:—Santa Elena, San Luis de La Paz, slow-speed chilean mills 2-roller type, 67.3% through 200 mesh; 1.84 tons per horse-power day; efficiency, 49.04%. Hacienda La Union, Pachuca, same as above; 80% through 200 mesh; 1.70 ton per horse-power day; mechanical efficiency, 46.13%. South Africa, heavy stamps and tube mills; 90% through 90 mesh; 1.53 tons per horse-power day; mechanical efficiency, 40.48%.

Putting the South African practice on a par with Mexican practice, it would appear that if the South African mills were crushing to the same fineness as those in Mexico the relative mechanical efficiency would be much lower.

In American practice the three-roller fast chilean mill gives the following:—39.4% through 200 mesh; 2.35 tons per horse-power day, mechanical efficiency, 55.73%. Owing to the relatively small amount through 200 mesh, it will be seen that this class of mill when crushing to the same degree of fineness as the mills in Mexico would lose to a large extent its relatively high mechanical efficiency in that work.

From the above figures it will be seen that when the fineness of the final pulp is taken into consideration, it is evident that the slow-speed chilean mill is a much more efficient machine to reduce ore to the required fineness as demanded by Mexican practice than any of the other combinations which have been tried in this work.

Itemized costs per ton of ore ground, as published by Mr. Megraw on actual work done at the Santa Elena mill, are as follows:—Labor, 0.03 pesos; lubrication, 0.01 pesos; power, 0.288 pesos; tires and dies, 0.129 pesos; extra repairs, 0.010 pesos; total, 0.467 pesos; Mr. Narvaez of La Union mill in Pachuca gives a cost of 0.558 pesos for reducing ore so that 80% will pass a 200-mesh screen. At the Santa Elena mill the ore is crushed so that 67.3% passes 200 mesh. Against this the cost of grinding a ton of ore to approximately the same fineness by use of stamps and tube mills will range from 65 centavos to over a peso per ton according to the size of the mill and nature of power used. In these figures there is no allowance made for depreciation either in chilean mills or stamps; nor is there any allowance made for crusher power; this being the same in either case.

The following are some of the apparent benefits to be gained by the use of chilean mills as compared with stamps. Less height required; cheaper foundations; fewer repair parts required; ability to withstand the

roughest handling; breakdowns and hence delays less than stamps; over feeding or under feeding does not hurt the mill; in some cases absence of all screens; operation by absolutely unskilled labor; slight attendance if mechanical feeders are used; repairs to nearly every part can be made on the ground; minimum vibration and hence minimum depreciation of mill; steel wearing parts will last from 18 months to two years.

Some changes which the author is endeavoring to introduce into Mexican practice are as follows:—(1). Improvement in the method of applying power to the mill. (2). Complete change in the form of pan used. (3). The trunnion shaft turning in a center bearing and not on the boss of the muller, where it is subject to grit dripping down the side of the muller and cutting out the bushing in which the shaft turns. (4). Device for allowing the mullers to lift independently over any unbreakable object. (5). Improved method of feeding the ore. (6). More screen discharge with which either the overflow method or screens can be used. (7). Adjustable chuck blocks.

FOREST FIRES AND THE RAILWAYS

ADVOCATING CO-OPERATION WITH THE FOREST SERVICE FOR THE PREVENTION AND CONTROL OF FIRES ALONG RAILWAY RIGHTS-OF-WAY

E. A. Sterling—Railway Age Gazette

WHATEVER may be the cause of the many fires which originate along railway rights-of-way the attitude of the public and even of state and government officials has generally been unfair to the roads. Little consideration has been given the fact that it is a costly operation to keep a right-of-way reasonably clear of inflammable material, and that even so, the rail-

road has no power to prevent the accumulation of debris outside the right-of-way where fires may as readily originate. As a fundamental preventative measure, the best mechanical engineers in the country have been sparing no pains and expense to perfect spark arresters which would be effective and practical. Some states have not as yet provided adequate means to cope with a fire

danger, yet have blamed the railways without shouldering a proportionate share of the burden.

Railways, in fact, can not afford to be indifferent to the destruction of forest property by fire, for both passenger and freight business would suffer thereby. Timber and lumber in many forms constitute a large percentage of the freight tonnage of many roads. While railway extension in the Northwest is generally attributed to agricultural development, yet fully 75 per cent of all eastbound freight originating west of the Cascades is composed of forest products. The road itself is a large consumer of such forest products, and its maintenance expense would be materially increased by the destruction of adjoining timber resources.

Unfortunately it has been only within recent years that the railways have realized that they should be active in the prevention and suppression of fires. Lack of education on the subject, or failure to appreciate the importance of forest products as a source of tonnage and of the forest as a resource and asset—effective policies regarding forest fires—were of slow development.

The active fire preventive work undertaken by roads falls under the three heads of compulsory, co-operative, and voluntary.

In New York state an example of compulsory action is the legislation enforced by the Public Service Commission, which requires all railways traversing the Adirondack region to use oil-burning locomotives during the day time from April 15 to November 1. The roads are also required to maintain a patrol during the summer, which has been attempted with varying degrees of success. Prior to this legislation some of the roads voluntarily maintained a patrol and operated special tank cars

equipped with pumps. Fuel oil in this region costs from 30 to 50 per cent more than coal, and in addition there is the cost of changing the locomotive furnaces twice a year. It is probable that closer voluntary co-operation between the railways and the state would have saved expense and trouble.

In Massachusetts and New Jersey protective clearance lines outside the right-of-way are permitted. In New Jersey the law provides that the roads shall construct through all forested land a safety belt 10 feet wide, 100 feet from the outer rail, and between this belt and the track cut out thick brush, trim large trees to a height of six feet and clear away all inflammable material. This law, while originally compulsory, is working out on a co-operative basis. The cost of these fire lines varies from \$125 to \$500 per mile, with an average of about \$180.

The New Minnesota legislation provides that "when, in the judgment of the state forester, there is danger of the setting and spreading of fires from locomotive engines, he shall order any railway company to provide patrolmen to follow each train throughout such fire patrol district or districts as he deems necessary to prevent fires." The same act also provides that the railways, independently of the state forester, shall patrol their right-of-way and take other steps to prevent the setting and spreading of fires.

In August of this year, State Forester Cox of Minnesota stated that "the railways have been brought to realize that a business-like system of fire protection is a paying proposition, and they have organized special forces of patrolmen on speeders and placed them where the district rangers feel that they will be most effective. The companies are also paying

more attention than formerly to the question of spark arresters on their locomotives."

During the last year the state forester of Wisconsin called a meeting of railway officials, timberland owners and others, and together they discussed ways and means of curbing the fire evil. The railway representatives present agreed unanimously on the following measures, which they believed would practically eliminate fires from locomotives:—

1. That the right-of-way be cleared of all combustible material under the direction of the fire wardens.

2. That the burning of debris on the right-of-way be controlled by the fire wardens.

3. That under special conditions there be a regular patrol, properly equipped with fire-fighting apparatus, following each train.

4. That all freight train crews keep a lookout from the top of the caboose, and that they be required to stop and put out fires when discovered.

5. That some means be devised to keep a strip 100 feet wide adjacent to the right-of-way free from slashings.

6. That there be as much improvement as possible in the mechanical construction of locomotives toward spark prevention.

In the Northwest the Western Forestry and Conservation Association, during 1911, patrolled sixteen million acres of land and spent over \$207,000 in fighting fire and maintaining 1,400 patrolmen. The timberland-owning railways of the West contribute directly to the maintenance of such associations, the Northern Pacific, during 1911, paying over \$14,000 through assessments. As the fire interests of the timberland owners are closely allied with the forest service, the states, and the railways,

there are now these four interests working in close harmony, and with excellent results.

It is illustrative of the present attitude of the western railways that they have been willing to go farther than the law requires in co-operating with the forest service for the reduction of fire losses.

When the Soo line was constructed across the Minnesota national forest, the railway plowed a strip of land 25 feet wide, the inner edge of which was 100 feet from the track, along both sides of the right-of-way throughout its entire length across the forest, except where natural fire barriers existed.

In April, 1910, the Great Northern and the Northern Pacific made voluntary agreements with the Department of Agriculture under which they agree to clear and keep free of inflammable material the right-of-way, and a strip of adjacent land not over 200 feet wide; equip all locomotives so as to prevent the escape of sparks and fire as far as practicable; establish an effective system of reporting fires on or near the right-of-way; give the use of company poles for forest service telephone and telegraph lines; grant permission to forest officers to operate speeders on company tracks in connection with patrol; take all possible action towards the prompt extinguishment of any fire discovered by railway employees; and reimburse the forest service for extra labor in extinguishing fires which start within 200 feet of the tracks. The forest service in return patrols the railway right-of-way during the fire season; furnishes, without expense, the services of available forest service employees for fighting fires on or near the right-of-way; pays for extra labor hired by the railway in extinguishing fires which started more than 200 feet

from the tracks; supervises the clearing of the company's right-of-way and adjacent land; constructs telephone lines to connect the headquarters of the forest officers with points on the railway; stores at convenient points sufficient tool equipment for successful fire fighting; and requires its employees to report immediately to the nearest agent of the company any defect discovered in the track or roadbed which might constitute a menace to safety.

The solution of the forest fire problem will come only by concerted action on the part of the interests vitally affected, and they can achieve the desired ends most quickly if supported by public sentiment and helpful legislation. A summing up of the measures which the railway companies could logically and profitably put into effect as their part in the work would be as follows:

First. Voluntary action to remove causes of complaint and reduce fire

liability. A clear right-of-way, efficient and carefully-inspected spark arresters, and patrol under conditions and in seasons which require it, would go far towards removing prejudice and keeping the railways' forest fire record clean.

Second. Co-operation with state and government officials and private land owners in preventing and controlling fires. This would include prompt reporting of fires by trainmen and other employees, assistance in fighting fires, and an understanding and co-operation in applying preventive measures.

Third. An educational campaign among employees and local residents, covering the danger and loss from forest fires and methods by which they can be controlled.

Fourth. Assistance, in so far as it can properly be rendered, in procuring helpful legislation and more liberal state and federal appropriations for forest protection.

WIRELESS STATIONS ON THE ATLANTIC COAST OF THE UNITED STATES

James L. Charlton—Electrical World

OF the fifty-four fully equipped wireless stations on the Atlantic seaboard, twenty-two are operated by the United States Navy, seven by the Army, sixteen by the United Wireless Telegraph Company, seven by the Marconi Company, and two by the United Fruit Company. In addition to these the navy operates five stations in the West Indies and Central America, the United Wireless three, and the United Fruit Company six. While there are other stations operated by other companies, the only one of these in constant commercial operation is that of the New York *Herald* situated at the

Battery on the lower end of Manhattan Island.

The Naval stations extend from Cape Elizabeth, Maine, to Key West, Florida, with two on the Gulf Coast—one at Pensacola, Florida, and the other at New Orleans. There is also a high-power station at Guantanamo, Cuba, the winter base of the Atlantic fleet, and there are two stations at the Isthmus, situated at Colon and Porto Bello respectively. By relaying, a message may be sent from one extreme of the navy circuit to the other without the slightest doubt that the message will reach its destination.

Besides handling the official business of the navy and keeping war vessels almost constantly in touch with the department at Washington, the naval stations send out a noon-time signal each weekday, followed by the weather report for the vicinity in which the station is located, and also, when storms are brewing, warnings received from the Weather Bureau. Ships in distress can always call these stations.

The Navy Department is gradually developing a standard transmitting unit, which will overcome some of the defects in the present equipments and be capable of transmitting with a wide range of wave lengths. A transmitter capable of a wide and quick change in wave lengths is very desirable; for in case of war and with the enemy trying to interrupt wireless communication, the wave lengths could, by a prearranged schedule, be changed until communication was established. In some of the sets being tried out on shipboard this is done with a very loose coupling and by plugging in sections or individual turns on the closed circuit helix.

The Navy Department has now a standard mast or tower for antenna suspension and will gradually replace the old wooden poles at all of the important shore stations. It is constructed of light angle iron and built in the form of a pyramid, being 9 feet square at the base and tapering to $2\frac{1}{2}$ feet at the top. Surmounting the top is a short wooden mast to which the antenna insulators are attached. The mast from base to extreme top is 200 feet high and rests on a wooden insulated platform. The recent equipment of the Newport station with two of these towers placed 550 feet apart has made that station one of the most important on the coast and has greatly extended its range of operation, with a record

of communication with Colon, Panama, a distance of nearly 2000 miles.

The new naval station now under construction at Arlington, near Washington, will have three towers, one 600 feet and the others 450 feet high. The equipment of this station will be ideal in every respect and when completed it will be one of the most powerful in the world. A twenty-four-hour watch is stationed at all naval shore stations year in and year out, there being as a rule four operators with a chief operator in charge.

Since the passage of the wireless-telegraphy act, effective July 1, 1911, there has been necessarily a large increase in installations on ships of all descriptions, and a great many of these installations have been by the United Wireless Company, which, in conjunction with the United Fruit Company, controls nearly all the commercial wireless business to and from steamers operating on the Atlantic coast of the United States, Mexico, Central America and the West Indies. Twenty-one of the United Fruit Company steamers carry wireless stations, and the Atlantic division of the United Wireless Company operates some 240 stations aboard vessels. An effective chain of commercial stations extends from Eastport, Maine, to Galveston, Tex., the average distance apart being 200 miles, consequently coastwise shipping is at all times within range of shore communication. It may be added that the Key West naval station handles the messages in that vicinity for both the United and the Marconi company.

While the United Wireless Company monopolizes practically all the north and south commercial wireless business of the Atlantic coast, the Marconi Company similarly monopolizes the transatlantic business. This company has seven stations on the

Atlantic coast; four of these are bunched close together between Cape Cod, Mass., and Sea Gate, L. I. Of the others, one is at Cape May, N. J., one at Virginia Beach, Va. and the other at Palm Beach, Fla. These last three stations have only lately been installed. The Marconi Company does a big business in messages and works very effectively. There are about eighty transatlantic ships which have Marconi installations. These ships do not individually do much long-distance sending, such communication being by relay, as there is practically always a chain of ships stretching across the Atlantic.

Three stations handle the New York business, namely, those at Siasconset, Mass.; Sagaponack, N. Y., and Sea Gate, N. Y. Cape Cod handles the Boston end, Cape May the Philadelphia end and Virginia Beach and Palm Beach handle the business from any Marconi ships that happen

to be bound south. There are also three stations on the southern coast of Nova Scotia which receive or transmit messages to the United States by land wire.

With the exception of Cape Cod, none of these stations are of high power. At Cape Cod (Wellfleet, Mass.) there are two stations, one of high and the other of low power. The low-power station is used for local work during the day and the other is used for press and long-distance messages at night. The large antenna of the high-power station is used only for transmission and not for receiving messages. This station has a duplicate at Poldhu on the western coast of England and each station has a maximum radius of transmission of about 1500 nautical miles. When midway across and when there is no abnormal static effect the liners often copy the press messages from both sides during the same night.

THE CEMENT GUN

A METHOD OF DEPOSITING CONCRETE RAPIDLY AND ECONOMICALLY

William A. Jordan—American Society of Engineering Contractors

HYDRAULIC cement as at present manufactured is a reliable and uniform material possessing definite and well known characteristics. To advance the position that concrete occupies among the building materials required only the discovery and exploitation of some method of application that would insure in the finished work a uniformity and strength never before attained. For this reason it is with this material that inventors have experimented more extensively than with any other.

The solution of the problem came with the discovery of the so-called

"Cement Gun." This apparatus was originally conceived by Mr. C. F. Akeley, a taxidermist of Chicago. His purpose was to obtain some method of rapidly and economically building up forms over which the skins of the larger mammals such as elephants and hippopotami might be stretched.

Mr. Akeley was also a member of the Field Museum Committee and had charge of the work of remodeling and preservation of one of the old World's Fair buildings which had been given to the Fields Museum Association. For this work Mr. Akeley conceived the very brilliant idea of

enlarging his "Cement Gun" and then to cover the entire building with stucco work by means of it. The experiment was highly successful and the work was performed rapidly and well within the allowable appropriation.

The Cement Gun, as it is used to-day, consists essentially of a hopper into which the cementitious materials are placed; a hose, connected with the bottom of the hopper through which the dry mixture is forced by compressed air; and a specially constructed nozzle at the end of the hose to which another hose supplying water is attached for hydrating the material.

In the process, the dry materials are forced through the hose by means of compressed air, hydrated at the nozzle, and shot into place with a muzzle velocity corresponding to a pressure of 35 pounds per square inch. The resulting product is of a quality never before attained by hand or any other machine process. The combinations of the elements, cement and water, necessary to produce the plastic material, takes place in transit.

A diagram of the gun is shown in Figure 1, and its working is explained as follows: Dry material is placed in cylinder "a." The valve "c" is closed, and the air pressure equalized in the cylinders "a" and "b." Valve "d" is then opened and material drops into the lower cylinder "b." The feed wheel "s" is revolved by an air motor through the gears "r" and "p." Compressed air admitted through the valve "f" blows the material upward and out through the goose-neck shown above the air pressure gauge into a flexible hose.

It is a well known chemical fact that the instant water is brought into contact with cement, the initial set, or chemical combination begins. The

initial set must be looked upon as the commencement of that hardening which gives the mass its ultimate strength. Hence, subsequent manipulation or handling tends to disturb this initial set, and, consequently, must weaken the product. These objectionable features are entirely overcome by the Cement Gun process;—the hydration taking place in transit and immediately before and during emplacement, and the chemical

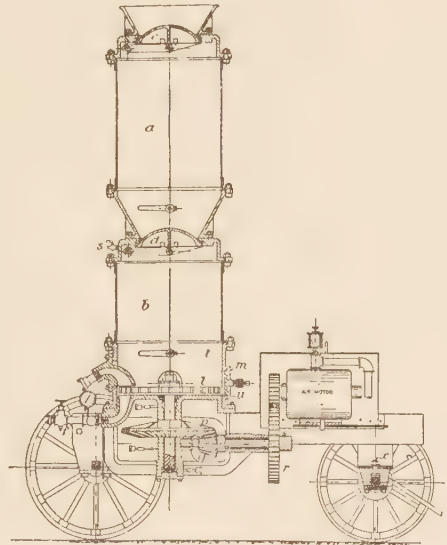


FIG. 1. DIAGRAM OF THE CEMENT GUN

combination or initial set taking place in its final resting place and not on the mixing board.

The Cement Gun employs only the necessary amount of water for the hydration of the cement, and because the materials are projected with considerable force, all surplus water and air are expelled. The product is a non-porous, impermeable mass, possessing the maximum density, which, by reason of these qualities, is practically waterproof.

In the Cement Gun the sand and cement are first mixed together in correct proportion while dry. This dry compound is deposited in the

hopper, from which it is fed into a powerful blast of air which conducts it through a suitable length of ordinary rubber hose until the nozzle is reached. Here, in the form of a fine spray, the water necessary for hydration is added at a pressure slightly in excess of the air pressure. The velocity with which the materials are travelling, however, is so great—300 feet per second—that hydration in reality takes place in the air, after leaving the nozzle, and is completed as the mixture is deposited. It is, of course, impossible to regulate the water thus admitted to precisely the amount theoretically required, as a very small variation in the air pressure alters the amount of dry material flowing from the machine, nor is such fine adjustment necessary or advisable. The mixture of sand, cement and water strikes the object or surface on which it is deposited with such force, that any surplus water contained is continually driven to the surface and flows away, just as in tamping and ramming a mass of wet concrete, a percentage of the surplus moisture is forced to the surface.

The Cement Gun has been used on a number of engineering projects

very successfully. Probably the most prominent place where it has been tried is the Panama Canal. Here it was employed to coat the disintegrating rock of the Culebra cut with concrete. The cost of labor and material for covering a square yard by means of the Cement Gun Process to an average thickness of two inches was about \$0.50. This, of course, was an exceptional case and the same results would not necessarily follow on other work. Old houses have been coated with stucco, for about the cost of painting them twice. New houses have been built at a cost below the best hand work, even though the resulting quality has been even better than that secured by the former methods.

As is usually the case with new inventions, there remains a great deal to be learned with regard to the Cement Gun and the Cement Gun Process, and new uses for the apparatus are being realized every day. The U. S. Government has been most energetic in taking it up, not only for work on the Panama Canal, but also for work in the City of Washington, in the building of barracks in Hawaii, in Porto Rico, and in the Philippines.

CONCRETE POLES IN ELECTRICAL SERVICE

THEIR CONSTRUCTION AND UTILITY AS EXEMPLIFIED IN THE UNITED STATES

W. Manktelow—Electrical Review

THOUGH wooden poles are still mainly used for the support of telegraph and telephone lines, the rapidly increasing number of pole lines, the decreasing supply of timber, and the steady increase in high-tension transmission and medium voltage central station distribution schemes, have led to extensive trials of other pole material and con-

struction, such as steel and reinforced concrete.

There are many duties for which wooden poles are sufficiently strong, but in which they are nevertheless being supplanted by reinforced concrete structures on account of the much greater durability of the latter, and, in municipal work, on account of the more pleasing appearance of

the concrete structure. Reinforced concrete poles are in limited use for the support of high-tension transmission lines, for in most cases lattice steel towers are preferred on account of their lower cost and easier transportation and erection.

In the construction of concrete poles from 4 to 12 reinforcing members are fixed symmetrically in a horizontal wooden or metallic mold to form a skeleton around which a suitable concrete mixture is well tamped. The most common pole sections are circular, square, and hexagonal, and it is customary to taper the poles at a rate between 1 in 100 and 1 in 200. By casting the pole with a central bore an improved utilization of material is secured, and a very convenient channel is provided in which to carry electrical conductors free from all risk of mechanical or chemical damage.

A suitable concrete mixture is one part of cement to two of sand and three or four of crushed marble, limestone, or other aggregate in $\frac{1}{4}$ to $\frac{1}{2}$ inch pieces. Steel bars or rods from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch in diameter may be employed as reinforcement, which may be twisted to increase cohesion between concrete and steel. Excellent results have been obtained in Oklahoma by reinforcing concrete distribution-line poles with 12 $\frac{1}{4}$ -inch twisted bars, each placed under 11,000 pounds tension until the concrete has thoroughly set.

The molds or forms used are in two parts and may be of wood or $\frac{1}{4}$ -inch galvanized iron with stiffeners at frequent intervals. If it is desirable to cast hollow poles a tapered core piece must be used, which must be removed directly the surrounding concrete will bear its own weight, for otherwise it may be impossible to remove it later. The number of cores required is only half

the number of forms in use at any one time.

The walls of hollow poles should be from 2 to 3 inches thick at least, and the reinforcement should be covered at every point with at least 1 inch of concrete. Considerable economy may be realized by casting such bolt holes as may be required for attachments to the pole during manufacture; ragged bolts and even cross-arm structures can be cast in the pole at negligible additional cost.

According to size and design, the cost of a pair of forms may range from £9 to £20. A gang of five men working on 12 to 16 forms should make 6 to 8 poles per day. The poles "set" in the forms for two days, and, after lying for a further four days, are seasoned for not less than ten days before use; even longer if possible. As with other concrete structures the pole strengthens with age; poles which have been in use for some years are found to be considerably stronger than those newly erected.

The erection of concrete poles is effected by the same means as are employed for wooden poles. Main strength alone suffices for the smaller sizes, but a derrick is necessary for larger poles. From 5 to 7 feet of the pole-butt is buried according to the nature of the foundation; in marshy districts, a deeper submersion may be necessary, and, in such a case, it is desirable to brace the pole to a creosoted rough timber foundation raft or grill (from 5 to 8 feet square), placed about 5 feet below ground level; the pole may penetrate this grill to any desired depth, and the footing should be filled in with rock and clay. A span of 100 to 150 feet is suitable for small poles, rising to 200, 300, or even 500 feet on heavy line and high-tension transmission routes.

Owing to their weight and indivisibility, concrete poles should be built as near as possible to the site of their utilisation.

The weight of reinforced concrete, as used in the present service, varies from 100 to 160 pounds per cubic foot, the corresponding weights of various timbers being:

Fir, red larch, pine...	30—42 lb. per. cu. ft.
White cedar, new....	39 “
Ditto, seasoned one year	25 “
Chestnut	34—43 “
Oak	50—60 “

The initial outlay on reinforced concrete poles in the United States of the class here considered, usually lies between 1s. and 2s. per foot of length, and averages 1s. 3d. per foot. The mean price of cedar poles in the States was 7s. 8d. each in 1909, *i. e.*, about 4d. per foot, assuming a mean length of 25 feet. Thus the cost of concrete poles appears to be three or four times as great as that of wooden poles, but it must be remembered that, in this comparison, the concrete poles are artistic products, ready for immediate erection in any surroundings and provided with all the necessary attachment sockets, bolts, etc., whereas the wooden poles are as delivered untreated from the timber yard. Much lower relative costs of concrete poles are claimed by some American makers, but it is not clear, in such cases, to what stage of the manufacture the estimates refer. Taking the overall cost from raw material to finished pole placed in service, it appears that concrete construction is 50-100 per cent more costly than wood, but the additional outlay is justified by the more pleasing result and by the negligible cost of attending to and repairing the concrete poles. No estimate can yet be made of the life of well-made reinforced concrete poles, but the demolition of certain poles which had

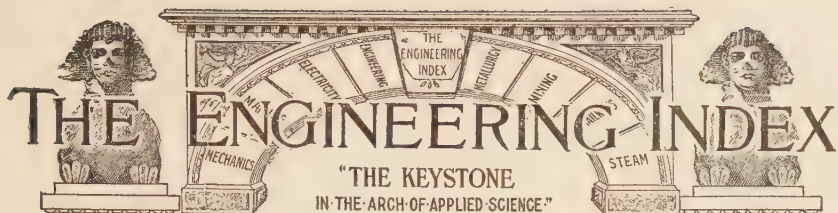
been in use for seven years showed no trace of surface or internal deterioration or moisture infiltration at any point.

Briefly reviewing the advantages and disadvantages of reinforced concrete poles—for telegraph and telephone lines, and central station distribution lines, lamp-posts and trolley-poles—as apparent from the present state of their development, it may be said that:—

Reinforced concrete poles are applicable to any special requirements, mechanical or architectural. They are costly and heavy, but they can be built as near as desired to the site of the erection, and being practically everlasting, their net annual cost is probably less than that of wooden poles. For a number of years the strength of the pole actually increases, and should failure occur at any time, the pole will rarely actually fall. A surprising degree of flexibility is attainable. Thus, a certain type of hollow pole, 30 feet long, tapering from 16 inches to 7 inches in diameter and having 2¾-inch walls and 12 ¼-inch twisted bars as reinforcement, gave 2½ feet deflection without sustaining injury, when subjected to 1,500 pounds lateral top pull.

It is interesting to note that in Oklahoma, concrete poles for ordinary central station distribution service have been adopted as standard, after careful trials extending over the past four years.

In short, reinforced concrete construction affords an excellent and economical substitute for wood in every pole service to which the latter is at present applied, but the concrete must at no point be expected to act as an electrical insulator or the reinforcing bars will be speedily destroyed and the entire replacement of the pole will be necessary.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

- (1) The title of the article,
- (2) The name of its author,
- (3) A descriptive abstract,
- (4) Its length in words,
- (5) Where published,
- (6) When published,
- (7) *We supply the article itself, if desired.*

✎ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes’ time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one’s special interest.

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CIVIL ENGINEERING

BRIDGES

Abutments

Cost of Concrete Abutments and Pedestals on Track Elevation Work Where Lack of Room Made Construction Difficult. Charles G. Huestis. Describes conditions and gives itemized costs. 1000 w. Engng & Con—Feb. 21, 1912. No. 30713.

Arches

The General Theory of Elastic Arch Ribs According to the Law of Least Work. William H. Burr. A general analysis for any conditions of loading, based upon both the principle of least work and upon elastic deflection of all of the several mem-

bers. 4500 w. Sch of Mines Qr—Jan., 1912. No. 30777 D.

An Arched Bridge with Suspended Road-bed (Eine Bogenbrücke mit aufgehängter Fahrbahn). Paul Frei. Details in the construction of a concrete bridge with reinforced arched members. Ills. 1700 w. Beton u Eisen—Jan. 18, 1912. No. 30556 D.

Bascules

Drawbridge in Constant Equilibrium Without Counterweight. A. Ramnekers and M. E. J. Gheury. Mathematical description. 800 w. Sci Am Sup—Feb. 24, 1912. No. 30741.

We supply copies of these articles. See page 165.

The Saybrook Bridge on the Connecticut River. Edward W. Bush. Read before the Conn. Soc. of Civ. Engrs. Illustrated description of a bridge 1800 ft. long and containing a two-arm Scherzer rolling lift draw affording a 200 ft. clear opening. 2000 w. Eng Rec—Feb. 17, 1912. No. 30470.

Bascule Bridges on the Brussels Maritime Canal (Ponts basculants du canal maritime de Bruxelles). Describes the operation of these new bridges. Ills. and Plate. 3800 w. Génie Civil—Jan. 20, 1912. No. 30619 D.

China

The Construction of the Huai River Bridge. Illustrated description of pneumatic caisson and cofferdam piers built on rock in very swift, deep water and nine spans erected by hand power. 3500 w. Eng Rec—Feb. 10, 1912. No. 30349.

Construction

Bridge Construction in Recent Years (Der Brückenbau in den letzten Jahren). A. Rohn. Review of some of the recent types of bridge construction with comparisons between types. Ills. 2500 w. Schweiz Bau—Jan. 27, 1912. No. 30543 D.

Cost Estimating

Method of Estimating Cost of Standard Reinforced Concrete Highway Bridges of Illinois Highway Commission Through Girder and Slab Types. B. H. Piepmeier. Abstract of paper before Ill. Soc. of Engrs. and Survrs. Develops a method of obtaining the approximate number of cu. yds. of concrete in a completed structure and of making estimate of the cost. 3500 w. Engng & Con—Jan. 31, 1912. No. 30143.

Culverts

The Flooding of the Approach End of a Culvert Due to a Small Rise in the Level of the Water at the Outlet End. John Goodman. An account of experimental investigation of this curious action. Ills. 3000 w. Inst of Civ Engrs—No. 3935. No. 30490 N.

Design

Preliminary Studies in Bridge Design. Reginald Ryves. General studies of river crossings and typical bridges, considering three primary types of rivers and streams, and five types of bridges. 3500 w. Surveyor—Feb. 9, 1912. Serial. 1st part. No. 30667 A.

Specifications for the Design of Bridges and Surveys. Discusses the paper by Henry B. Seaman. 3500 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30906 F.

Drawbridges

See Bascul, under *Bridges*.

Failures

See Track Reconstruction, under RAILWAY ENGINEERING, *Permanent Way and Buildings*.

Floors

Specifications for and Cost of Replacing Wood Floors with Reinforced Concrete, for Highway Bridges. Leroy C. Smith.

Gives specifications for work of the Michigan State Highway Department. 2000 w. Engng & Con—Feb. 14, 1912. No. 30424.

Plate Girders

The Keystone Bridge of the Western Maryland Railway. Walter Shultz. Illustrated detailed description of a structure at Keystone, Pa. 1000 w. Eng Rec—Jan. 27, 1912. No. 30069.

Railroad Bridges

A New Double-Track Railroad Bridge Over the Rhine near Homberg. Profile and brief description of a bridge having the longest unconnected trusses in Europe. 1500 w. Eng Rec—Feb. 3, 1912. No. 30254.

Reinforced Concrete

Reinforced Concrete Bridges Built Over Current River, in the City of Port Arthur, Ontario. L. M. Jones. Illustrates and describes designs and construction of bridges completed in the year 1911. 1500 w. Can Engr—Feb. 15, 1912. No. 30452.

See also Viaducts, under *Bridges*, and Cost Estimating, under *Construction*.

Repairs

Replacing Worn Bridge Pins in the Field. H. C. Lothholz. Illustrates and describes a novel method used on the C., M. & St. P. Ry. 1200 w. Eng News—Jan. 25, 1912. No. 30094.

Repairing the Substructure of the Bangor-Brewer Bridge. E. E. Greenwood. Describes work on a bridge across the Penobscot River, in Maine, consisting of enclosing old piers in a jacket of reinforced concrete. 1500 w. Eng Rec—Feb. 24, 1912. No. 30734.

Steel

Weak Points in the Construction of Small Steel Highway Bridges. Neal B. Garver. Abstract of a paper before the Ill. Soc. of Engrs. & Survs. Discusses modifications needed in methods. 1500 w. Eng News—Feb. 15, 1912. No. 30437.

St. Louis, Mo.

The St. Louis Municipal Bridge. S. W. Bowen. Illustrated description of this combined railway and highway structure being built across the Mississippi River. 6500 w. Eng News—Feb. 8, 1912. No. 30355.

Viaducts

The Reinforced Concrete Viaduct at Gilbert Avenue, Cincinnati. Frank L. Raschig. Plan, sections, history and description of this viaduct. 4500 w. Engng & Con—Feb. 7, 1912. No. 30375.

New Radcliffe Viaduct on Great Northern of England. C. Van Langendonck. Illustrated description of a viaduct 1254 ft. long, built originally of timber, but recently rebuilt of brick. 700 w. Ry Age Gaz—Feb. 9, 1912. No. 30360.

Reinforced Concrete Shear Beams (Gerberträger aus Eisenbeton). Stoetzer and Böhm. Describes a viaduct supported by reinforced concrete beams. Ills. 1500 w. Beton u Eisen—Jan. 3, 1912. No. 30552 D.

CONSTRUCTION

Breweries

The New Municipal Brewery in Pilsen (Die Neuanlagen des Bürgerlichen Brauhauses in Pilsen). Fr. Spalek. Plans and description of a new plant. Serial. 1st part. 2400 w. Zeit d Oest Ing u Arch Ver—Jan. 19, 1912. No. 30537 D.

Buildings

Poured Houses in Holland. George E. Small. Illustrates and describes this system of building reinforced concrete. 1200 w. Cement Age—Feb., 1912. No. 30758 C.

Regulations for Separate Building Construction (Vorschriften für offene Bebauung). Stating the new building regulations at Zurich requiring spaces between houses, etc., in certain zones. Plans. 2500 w. Schweiz Bau—Feb. 3, 1912. No. 30544 D.

A Reinforced Concrete Theatre in Frankfurt a M. (Die Eisenbetonkonstruktionen im Neuen Theater zu Frankfurt a. M.). E. Neugeboren. Plans and details of construction. Ills. 2200 w. Beton u Eisen—Jan. 18, 1912. No. 30557 D.

The Klagenfurt "Jubilee Theatre" (Das Klagenfurter "Jubiläums-Stadttheater"). Em. Eichholz. Description of new municipal theatre built of reinforced concrete. Ills. Serial. 1st part. 2200 w. Beton u Eisen—Feb. 2, 1912. No. 30559 D.

The Travellers' Hall on the Island of Borkum (Die Wandelhalle auf der Insel Borkum). A. Ritter. Detail of a large pleasure resort built of reinforced concrete. Ills. 4200 w. Beton u Eisen—Jan. 3, 1912. No. 30553 D.

Caissons

Floating Docks for Setting Caisson Blocks of Reinforced Concrete in Kobe Port, Japan (Dock flottant pour l'immersion de caissons-blocs en beton armé du port de Kobé-Japon). A. Delisle. Description of dock and caissons. Ills. 2400 w. Génie Civil—Jan. 13, 1912. No. 30615 D.

Cement Gun

The Cement Gun, Gunite, and Their Uses. Illustrated description of a new process for supplying cement, which dispenses with forms, and some of the uses to which it is applied. 2000 w. Engr, Lond—Jan. 19, 1912. No. 30181 A.

The Cement Gun. William A. Jordan. Illustrates and describes this device for placing concrete, its use, tests, etc. General discussion. 9000 w. Jour Am Soc of Engng Con—Dec., 1911. No. 30900 N.

Columns

The Bending Resistance of Built-Up Columns (Ueber den Knickwiderstand gegliederter Stäbe). R. Saliger. Treating on the bending moments of various built-up sections. Ills. Serial. 1st part. 2600 w. Zeit d Oest Ing u Arch Ver—Jan 5, 1912. No. 30536 D.

Concrete

Concrete Construction. E. Brown. Abstract of paper read before the Montreal

Bldrs. Exchange. Discusses the properties and the variations due to mixing and the desirability of a working standard. 2000 w. Can Engr—Feb. 1, 1912. No. 30247.

A Discussion of the Economics of Practical Concrete Construction. DeWitt V. Moore. Read before the Indiana Engng. Soc. A study of methods of concrete construction with particular regard for costs. 4500 w. Engng & Con—Feb. 14, 1912. No. 30423.

An English Proposed System of Forms for Building Construction. H. Kempton Dyson. Abstract of a paper in *Concrete and Construction Engng*. Illustrates and describes the design. 3000 w. Engng & Con—Feb. 28, 1912. No. 30859.

Cold Weather Concrete Work. John S. Nicholl. Illustrated account of successful work, stating necessary precautions. 2000 w. Cement Age—Feb., 1912. No. 30760 C.

See also Buildings, and Waterproofing, under *Construction*.

Construction Camps

Sanitary Regulations Governing Construction Camps. Jerome Cochran. Discusses the sanitary conditions to be maintained to protect health when construction camps are necessary. 4000 w. Cornell Civ Engr—Feb., 1912. No. 30874 C.

Conveyers

See same heading, under MECHANICAL ENGINEERING, *Transporting and Conveying*.

Costs

Comparison of Plant and Operating Cost of Day Labor and Contract Work in the U. S. Improvement of the Upper Mississippi River. Charles W. Durham. Outlines the work and compares the U. S. labor plants and operating costs with those of the best contractors. Ills. 2000 w. Engng & Con—Jan. 24, 1912. No. 30098.

In What Manner Are the Costs of Projects and Estimates to Be Defrayed (In welchen Fällen sind Projectarbeiten und Kostenanschläge zu bezahlen)? W. Beck. Treating of the costs of engineering service and estimates. Serial. 1st part. 2800 w. Elektrotech Rundschau—Jan. 4, 1912. No. 30529 D.

Crushing Plant

Rock Crushing Plant, Kensico Dam. Samuel W. Traylor. Illustrated description of a very large stone-crushing plant, with a maximum capacity estimated at 500 cu. yds. per hour. 2200 w. Eng News—Feb. 22, 1912. No. 30719.

Drainage

See same heading, under *Waterways and Harbors*.

Embankments

See same heading, under RAILWAY ENGINEERING, *Permanent Way and Buildings*.

Excavation

Method of Solidifying Chambered and Fissured Rock for Excavation for Power

House and Dam Foundation. C. H. Tisdale. (Abstract.) Describes grouting operations to secure solid foundations at Hales Bar, Tennessee River. Ills. 2000 w. Engng & Con—Jan. 24, 1912. No. 30097.

Excavators

Electricity in Excavation Work. W. C. Lancaster. Describes and illustrates installations where the electric motor has been used, and explains its application to excavation work. 3000 w. Gen Elec Rev—March, 1912. No. 30764 C.

Electric Power in the Construction of the Vistula Canal (Elektrischer Antrieb der Baumaschinen bei der Kanalisation der Weichsel). J. Weingrün. Giving the kinds of machines in use and mode of obtaining power. Ills. 2800 w. Elek u Masch—Jan. 21, 1912. No. 30524 D.

Electric Excavators (Der Arbeitsverbrauch des elektrischen Trockenbaggers). P. Sanio. Treats on electric motive apparatus for electric excavators. 2300 w. Elek Kraft u Bahnen—Jan. 24, 1912. No. 30584 D.

Fire Prevention

The Equitable Life Building Fire. An illustrated account of this fire and the conditions that interfered with its control, with the preliminary report of the N. Y. Board of Fire Underwriters. 2500 w. Ins Engng—Jan., 1912. No. 30907 C.

Foundations

Method of Constructing Gas Holder Foundations in Soft Soils With Some Costs. Principally a description of the foundations of the gas holder of the New Haven Gas Lgt. Co. Ills. 1500 w. Engng & Con—Feb. 21, 1912. No. 30712.

Gasholder Foundations in Soft Soils. Hunlay Abbott. Illustrated detailed description of work at New Haven, Conn. 2200 w. Am Gas Lgt Jour—Jan. 29, 1912. No. 30072.

The Zinn Building. T. Kennard Thomson. A building in N. Y. City, having foundations in made ground over river silt, and local conditions adding to the difficulties. 1500 w. Can Engr—Feb. 22, 1912. No. 30727.

Constructing the Foundations of the Seamen's Church Institute, New York. Describes the foundations of a 12-story structure carried about 40 feet below the street. Pneumatic wall caissons were sunk through mud, clay, sand, and hard-pan, bonded together and braced across the lot. Ills. 3000 w. Eng Rec—Jan. 27, 1912. No. 30071.

The Steel Substructure of the Woolworth Building in New York City. Illustrates and describes the massive foundation girders and grillages for this building, providing for an estimated weight of about 125,000 tons. 1500 w. Eng Rec—Feb. 17, 1912. No. 30466.

The Substructure of the New Daniels & Fisher Stores at Denver. Reinforced-concrete footings are employed and there

are unusual examples of cantilever supports for some of the columns. Ills. 1500 w. Eng Rec—Feb. 10, 1912. No. 30347.

Hospitals

The Erection of the Imperial General Hospitals (Die Neubauten des k. k. Allgemeinen Krankhauses). B. Piekniczek. Plans and description of building having twenty-three separate wards for treatment of medical and surgical cases. Serial. 1st part. 2400 w. Zeit d Oest Ing u Arch Ver—Jan. 5, 1912. No. 30535 D.

The University Women's Clinic of the New Imperial General Hospital in Vienna (Die Universitäts-Frauenkliniken des neuen Wiener k. k. Allgemeinen Krankhauses). R. Jaksch. Details the construction of this new building. Ills. 4400 w. Zeit d Oest Ing u Arch Ver—Feb. 2, 1912. No. 30539 D.

Joints

Tests on the Strength of Nailed Joints. J. H. Thornley. Reports a nail test made in connection with the design of the Porcupine Power Co.'s hydro-electric plant at Sandy Falls, Ont. Ills. 2000 w. Ap Sci—Feb., 1912. No. 30884 C.

Methods

Some Unusual Construction Methods and Plants Employed on a Large Contract. Illustrates and describes work at South Bend, Ind. 1500 w. Engng & Con—Feb. 28, 1912. No. 30860.

Piling

Calculations on the Dimensions and Supporting Power of Pile Foundations (Calcul des dimensions et du pouvoir porteur des pieux de fondation). Ch. Dantin. Mathematical discussion. 6400 w. Génie Civil—Jan. 27, 1912. No. 30621 D.

Roofs

Graphic Means for Determining Rod-Support Spacing in Roofs Inclined at Various Angles (Graphische Ermittlung der Stabspannung eines eisernen Dachbinders mit verschiedener-gebrochener-Dachneigung). W. Schulz. Graphic design for sway-bracing under such conditions. 2500 w. Elektrotech Rundschau—Jan. 11, 1912. No. 30530 D.

Specifications

The Principles of Specification and Agreement Writing. C. R. Young. First of a series of articles discussing the art of fully, accurately and unambiguously describing the features and details adopted. 2500 w. Can Engr—Feb. 8, 1912. Serial. 1st part. No. 30371.

Engineering Specifications. Michael Longridge. Inaugural address before the Manchester Assn. of Engrs. On the relationship between purchasers, contractors, and consulting engineers, and the problems that arise out of engineering work as controlled by specifications. 5800 w. Mech Engr—Jan. 19, 1912. No. 30163 A.

Steam Shovels

130-Ton Steam Shovel for Rock Work. Illustrated detailed description of a shovel

designed to meet severe requirements. 1500 w. Eng News—Jan. 25, 1912. No. 30093.

See also Panama Canal, under *Waterways and Harbors*.

Tunnels

A Tunnel Street. Illustrates and describes a construction in upper part of New York City to provide access to a subway station. 1600 w. Munic Jour & Engr—Feb. 8, 1912. No. 30340.

Underpinning

Underpinning an Electric-Light Station. Illustrates and describes interesting methods used in repairing the Carroll St. sub-station, in Brooklyn, N. Y. 2200 w. Eng Rec—Feb. 17, 1912. No. 30469.

Warehouses

A Reinforced Concrete Piano Warehouse. Illustrates and describes an example of cantilever construction recently completed at Newark, N. J. 1000 w. Eng Rec—Jan. 27, 1912. No. 30066.

Waterproofing

Waterproofing Concrete Structures on C., B. & Q. Track Elevation. G. A. Hag-gander. Illustrates and describes methods used in Chicago. 1800 w. Ry Age Gaz—Feb. 16, 1912. No. 30460.

Wind Bracing

Wind Bracing in the Woolworth Building. Illustrates and describes the bracing systems used for a 30-story building having a tower of 55 stories above the curb. 1700 w. Eng Rec—Feb. 24, 1912. No. 30736.

MATERIALS OF CONSTRUCTION

Building Stones

Granites, Marbles, and Other Building Stones of the South. Ernest F. Burchard. Remarks on the importance of stone as a mineral product, and the stone resources of the south, their distribution, etc. 3500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30747 D.

Tests on Fireproof Stone (Prüfung feuerfeste Steine). M. Gary. Gives results on ten stones tested to the melting point. 2400 w. Zitschr des Ver deutscher Ing—Jan. 6, 1912. No. 30564 D.

Cement

Final Report of the Special Committee on Uniform Tests of Cement. Report with description of methods of testing. 8500 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30901 F.

Hardness of Plasters and Cements, and a Simple Chronographic Apparatus for Recording Set. Charles F. McKenna. Explains the term "hardness" as applied to cement, and illustrates and describes apparatus for observing changes in the setting process. 2500 w. Cement—Jan., 1912. No. 30444 C.

See also Cement Gun, under *Construction*.

Concrete

Directions and Suggestions for the Inspection of Concrete Materials. Jerome

Cochran. First of a series of articles describing current practice in the inspection of concrete. 6500 w. Engng & Con—Jan. 31, 1912. Serial. 1st part. No. 30142.

Proportioning Gravel Concrete. Clifford Older. Read before the Ill. Soc. of Engrs. & Survs. Gives general specifications for gravel concrete which have resulted in satisfactory work. 3000 w. Eng Rec—Feb. 3, 1912. No. 30253.

Uses and Misuses of Concrete and Reinforced Concrete. DeWitt V. Moore. Considers uses for which this material is adapted, its proper application, etc. Ills. 4000 w. Cement & Engng News—Feb., 1912. No. 30821.

See also same heading, under *Construction*.

Hollow Tile

Proposed Specifications for Hollow Clay Tile Building Blocks. Virgil G. Marani. Gives specifications recommended by the Building Dept. of Cleveland, O., after exhaustive tests. 1500 w. Eng News—Feb. 8, 1912. No. 30357.

Lumber

The South's Lumber Problem. Hu Maxwell. Urges the manufacture of the woods into commodities instead of shipping lumber. 2500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30756 D.

Reinforced Concrete

Reinforced Concrete in Great Britain. W. Noble Twelvetees. The present number considers the nature of this material, introductory to a discussion of the systems. 3000 w. Builder—Jan. 26, 1912. Serial. 1st part. No. 30293 A.

The Specialist Constructor of Reinforced Concrete. From a paper by Lucian Serraillier, in *Concrete & Constructional Engng*. Discusses the proper position of these specialists in the engineering field. 2500 w. Engng & Con—Feb. 21, 1912. No. 30711.

Reinforced Concrete in Maritime Work (Il cemento armato nelle opere marittime). The possibilities of reinforced concrete in pilings, sea walls, etc. Ills. 2800 w. Monit Tecnico—Jan. 30, 1912. No. 30634 D.

See also Reinforced Concrete and Viables, under *Bridges*; Buildings and Warehouses, under *Construction*; Wharves, under *Waterways and Harbors*; and Coal-ing Stations, under RAILWAY ENGINEERING, *Permanent Way and Buildings*.

Reinforced Concrete Beams

Calculations on Reinforced Concrete Beams (Calcul des Poutres en Ciment Armé). M. Pigeaud. Mathematical studies of their properties. 12000 w. Ann des Ponts et Chaussées—Nov., 1911. No. 30597 E + F.

Deflection of Reinforced Concrete Beams (Die Berechnung der Durchbiegung von Eisenbetonbalken). G. Kaufmann. Mathematical discussion. 2700 w. Beton u Eisen—Jan. 3, 1912. No. 30555 D.

Beam Tests (Balkenversuche). F. v. Emperger. Discussion on the calculation for reinforcement spacing in reinforced concrete beams. 1800 w. Beton u Eisen—Feb. 2, 1912. No. 30560 D.

Reinforced Concrete Slabs

Timber Floors on a Skeleton Frame of Reinforced Concrete. Francis W. Wilson. Describes a type of construction aiming to combine the good points of concrete factory building construction and the wood floors of mill construction. Ills. 2500 w. Cement Age—Feb., 1912. No. 30759 C.

Reinforcing

Experiments with Laced Cast Iron Reinforcing (Versuche mit umschnürtem Gusseisen). Dr. v. Emperger. Presents data of tests of concrete columns with different degrees of laced reinforcement. Ills. Serial. 1st part. 2200 w. Beton u Eisen—Feb. 2, 1912. No. 30558 D.

Sand-Washing

Improved Sand-Washer. Illustrated description of a filter-bed sandwashing plant devised by William Polglase. 1200 w. Engr, Lond—Feb. 16, 1912. No. 30803 A.

Timber

Strength Values for Structural Timbers. McGarvey Cline. Gives results of tests made by the U. S. Forest Service. 1500 w. U S Dept of Agri, Circ 189—Jan. 25, 1912. No. 30912 N.

Our Forest Fires. T. M. Prudden. Brief account of methods of fighting forest fires, and of their prevention. Ills. 2000 w. Yale Sci M—Feb., 1912. No. 30849 C.

The Railways' Interest in Forest Fire Prevention. E. A. Sterling. A discussion of the forest fire problem and the responsibility of railways. Ills. 4000 w. Ry Age Gaz—Feb. 9, 1912. No. 30359.

Timber Preservation

Creosote Specifications and Analysis. S. R. Church. Abstract of an address before the Wood Preservers' Assn. Considers the principal specifications in use in the United States, their origin and value. 3000 w. Ry Age Gaz—Feb. 16, 1912. No. 30457.

The Decay and Preservation of Timber. William Ransom. The present number deals with causes of decay. 1000 w. Surveyor—Jan. 26, 1912. Serial. 1st part. (Special.) No. 30310 C.

MEASUREMENT

Accelerometer

The Wimperis Accelerometer and Equilibratist. H. E. Wimperis. Illustrated description of the pocket form and the recording form of instrument. 1100 w. Bul Int Ry Cong—Jan. 1912. No. 30129 G.

Meters

A Recording Current Meter. Charles Lane Poor. Illustration and brief description of a current recorder for measuring and recording the velocity and direction of currents. 1200 w. Yale Sci M—Feb., 1912. No. 30852 C.

Measurement of Water, Means Available and Their Relative Accuracy. Gardner S. Williams. Considers methods and devices used. 6500 w. Jour W Soc of Engrs—Jan., 1912. No. 30814 D.

Special Venturi Meters at the Wachusett Dam. E. R. B. Allardice and F. N. Connet. Illustrated description of meters and recording instruments. 1000 w. Eng News—Feb. 15, 1912. No. 30435.

The Woltmann Water Meter (Ueber Woltmann-Wassermesser). L. Arndt. A new type of meter for measuring the velocity of the current. Ills. 2500 w. Oest Wochenschr f d Oeff Baudienst—Jan. 11, 1912. No. 30551 D.

Surveying

The Relative Advantages of Land Surveying Methods, With Reference to Speed, Accuracy, and Applicability. G. W. Pickels, Jr. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Briefly describes and discusses the three methods used, and compares them. 3000 w. Engng & Con—Jan. 31, 1912. No. 30149.

The Present Activities of the Coast and Geodetic Survey. O. H. Tittmann. Considers present progress, conditions and problems of this work. Discussion. Ills. 5500 w. Pro Engrs' Club of Phila—Jan., 1912. No. 30823 D.

MUNICIPAL

Drainage

See same heading under *Waterways and Harbors*.

Purification

Two German Sewage Purification Works. Abstract translation of articles by Messrs. Balch and Blunk, describing plants at Graf Schwerin and at Holzwickede. Ills. 3000 w. Munic Jour and Engr—Feb. 22, 1912. Serial. 1st part. No. 30728.

Refuse Disposal

Refuse Disposal in Cambridge, Mass. From a recent report of a Committee appointed by the City Council. Deals with the collection and disposal of refuse. 2500 w. Munic Engng—Feb., 1912. No. 30700 C.

The Destruction of House Refuse by Incineration. Ray R. Knight. Considers incinerator plants, methods, costs, etc. 4500 w. Can Engr—Feb. 8, 1912. No. 30370.

The Proper Disposal of Domestic Wastes in Rural Districts. John Brook. Read before Inst. of Munic. Engrs., at Birmingham, Eng. Considers the requirements, conditions, and systems recommended. 2000 w. Surveyor—Jan. 19, 1912. No. 30160 A.

Sewage Disposal

The Need of Well Considered Design and Efficient Operation of Sewage Disposal Plants. Langdon Pearse. Abstract of a paper before the Ill. Soc. of Engrs. & Survs. Brief study of the progress made in sewage disposal. Ills. 2000 w. Engng & Con—Jan. 31, 1912. No. 30145.

The Use and Abuse of Sewage Disposal Plants. Chester A. Smith. Abstract of a paper before the Kansas Engng. Soc. Shows that plants are usually installed as a matter of convenience and necessity, and that the public need instruction in regard to their operation and effect on health. 2000 w. Engng & Con—Feb. 7, 1912. No. 30377.

Septic Tank System of Waste Disposal. F. W. Tower. Explains a process of sewage reduction and gives suggestions on design of tanks. 1500 w. Met Work—Feb. 16, 1912. No. 30450.

Electrolytic Sewage Treatment. C. L. Edholm. Illustrated description of plants at Santa Monica and Oklahoma City, with results and costs. 1200 w. Munic Jour & Engr—Feb. 8, 1912. No. 30341.

The Most Important Sewerage and Sewage Disposal Report Made in the United States. Reviews the report of Messrs. Hazen and Whipple advising the city of Pittsburgh to disregard the recommendations of the Pennsylvania Health Department. 6000 w. Eng Rec—Feb. 24, 1912. No. 30733.

Lethbridge Sewage Disposal Works. Plans and description of Canadian works having an interesting design of sedimentation tank. 2000 w. Can Engr—Feb. 1, 1912. No. 30248.

The Madison-Chatham Sewage Disposal Works. Illustrates and describes a joint project in New Jersey, involving the construction of Imhoff tanks, contact beds, and sand filters. 3000 w. Eng Rec—Jan. 27, 1912. No. 30067.

Imhoff Tanks at Madison-Chatham, N. J. Clyde Potts. Illustrated description of this feature of a joint disposal plant. 1000 w. Cornell Civ Engr—Feb., 1912. No. 30875 C.

Batavia, N. Y., Sanitary Sewer System. R. L. Fox. Illustrated description of a system comprising 32 miles of separate sewers, a pumping station and disposal plant. 2500 w. Cornell Civ Engr—Feb., 1912. No. 30873 C.

The Sewage Disposal Works at Baltimore. Electricity for light and power is supplied by turbines operated by the effluent from 12 acres of sprinkling filters. Ills. 3500 w. Eng Rec—Feb. 24, 1912. No. 30731.

The Design of the Sewage Disposal Plant at Winchester, Kentucky. Charles E. Collins. Plans and description of the construction of Imhoff sewage clarification tank, sludge drying bed, inverted siphon, etc. 1000 w. Engng & Con—Feb. 14, 1912. No. 30426.

Lawrence Experiment Station Studies in the Purification of Sewage. Summary of studies made by H. W. Clark and Stephen DeM. Gage, as given in the report of the Mass. State Board of Health for 1910. 5000 w. Engng & Con—Jan. 24, 1912. No. 30099.

Sewage Disposal in Philadelphia. Illustrated detailed description of the, Holmesburg sewage treatment plant. 4000 w. Munic Jour & Engr—Feb. 1, 1912. No. 30215.

Sewers

Cost of Trenching with Sewer Excavation in Moundsville, W. Va. A. W. Peters. Tabulated costs with description of work. 1500 w. Engng & Con—Feb. 28, 1912. No. 30862.

Drainage Improvements and Intercepting Sewer System for Syracuse, N. Y. Stephen B. Vernon. Brief illustrated description of designs and details of the Harbor Brook improvement and the sewer constructed to intercept the flow of sewage into this stream. 1000 w. Cornell Civ Engr—Feb., 1912. No. 30877 C.

The Susquehanna River Intercepting Sewer. Illustrates and describes work at Harrisburg Pa., in order to improve conditions of the water front. 1500 w. Eng Rec—Feb. 24, 1912. No. 30735.

Main Drainage Works, Toronto, Canada. R. C. D. Tempest. Illustrates and describes the sewerage system, explaining conditions to be met. 1500 w. Cornell Civ Engr—Feb., 1912. No. 30878 C.

A Brief Sketch of the Havana (Cuba) Sewer and Drainage System. H. E. Hyde. Ills. 4500 w. Cornell Civ Engr—Feb., 1912. No. 30876 C.

ROADS AND PAVEMENTS

Asphalt

Cost of Maintaining Asphalt. Gives average costs in Rochester, Buffalo, and Brooklyn, N. Y., covering sixteen to twenty year periods. 2500 w. Munic Jour & Engr—Feb. 1, 1912. No. 30216.

Bituminous

Bituminous Macadam Construction. A. N. Johnson. Read before the Indiana Engng. Soc. Deals in detail with this form of construction. 5000 w. Munic Engng—Feb., 1912. No. 30698 C.

History of the Washington Bituminous-Concrete Pavements. Mark Brooke. Read before the Am. Assn. for the Adv. of Sci. 3000 w. Eng Rec—Feb. 3, 1912. No. 30257.

Concrete

Method and Cost of Constructing a Concrete Street Pavement. Howard Eggleston. Record of laying concrete pavement in a street and constructing cement sidewalks under difficult conditions. 2000 w. Engng & Con—Feb. 28, 1912. No. 30861.

See also Bituminous, under *Roads and Pavements*.

Construction

Practical Road Building. John N. Edy. The present article discusses the construction of earth roads. Ills. 2000 w. Munic Engng—Feb., 1912. No. 30695 C.

Costs

Mileage and Cost of Public Roads in the United States in 1909. J. E. Pennybacker,

Jr., and Maurice O. Eldridge. Explanation and analysis of mileage and cost statistics. 120 pages. U S Dept of Agri, Bul 41—Jan. 26, 1912. No. 30650 N.

Experimental Roads

The Park Heights Experimental Road, Baltimore, Md. D. M. Avey. Information concerning the road, with results of recent inspection. Ills. 3000 w. Munic Engng—Feb., 1912. No. 30697 C.

Highways

I. The Improvement of Highways to Meet Modern Conditions of Traffic. Jonah Walker Smith. II. Recent Development in Road-Traffic, Road-Construction and Maintenance. Henry Percy Maybury. With abstract of discussion on the papers. Plates. 146 pages. Inst of Civ Engrs—No. 3939 and No. 3946. No. 30494 N.

Connecting Two Cities by a Roadway 100 Feet Wide Built on Marsh Land. Illustrates and describes improvements in progress, and construction difficulties, in replacing an old plank road between Newark and Jersey City which carries heavy traffic. 2500 w. Eng Rec—Feb. 17, 1912. No. 30468.

New Hampshire Highways. Charles H. Hoyt. Report of an inspection of highways in the State of New Hampshire, Aug., 1911. Contains much information. Ills. 40 plates. 35 pages. U S Dept of Agri, Bul 42—Feb. 6, 1912. No. 30651 N.

New Hampshire's Road System. Illustrates and describes methods of maintaining the improved highways. 1600 w. Horseless Age—Feb. 28, 1912. No. 30866.

Honduras

Transportation Development and Projects in Honduras. Edward W. Perry. Considers conditions affecting the present and future development of the industries. Ills. 3000 w. Engineering Magazine—March, 1912. No. 30832 B.

Improvement

Road Improvement in the South, Past and Present. Logan Waller Page. Gives an account of early road building, and the present status of road work. 4500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30746 D.

Labor

Convict Labor on State Roads. Report of an experiment carried out by Onondaga Co., New York. 2500 w. Eng Rec—Feb. 10, 1912. No. 30346.

Oil-Macadam

The Failure of Certain Expensive Oil Macadam Roads in Los Angeles County, California. A critical discussion of the work of the old Los Angeles Co. Highway Commission. Ills. 1200 w. Engng & Con—Feb. 28, 1912. No. 30858.

Slag

The Youngstown (O.) Slag Road. Information concerning the construction and results with this material as used on an experimental road built in 1909. 2500 w. Munic Engng—Feb., 1912. No. 30699 C.

Stone

Stone Pavements of England and America. Ernest Flagg. From the *Century Mag.* A comparison of pavements and methods of constructing them. Ills. 2500 w. Munic Engng—Feb., 1912. No. 30696 C.

Street Tunnels

See Tunnels, under *Construction*.

Surfacings

The Relation of Modern Road Surfacings to Fish Life. W. J. A. Butterfield. Read before the Inst. of Munic. & Civ. Engrs. An investigation of the effect of surface workings from roads on the fish life of streams into which they pass. Also discussion. 15000 w. Surveyor—Feb. 16, 1912. No. 30793 A.

Surface Treatment of Park Roads in Washington, D. C. Spencer Cosby. Read before the Am. Assn. for the Adv. of Science. Brief explanation of methods tried and results. 2500 w. Engng & Con—Jan. 31, 1912. No. 30144.

Wood Block

Crescoted Wood Block Pavement with Cement Grout Filler. A. J. Schafmayer. Read before the Ill. Soc. of Engrs. & Survs. Facts about certain features of the design and construction of a pavement laid in Chicago in 1911. 2500 w. Eng Rec—Feb. 10, 1912. No. 30348.

Wood Paving Experiments in Minneapolis. A progress report giving the results of four years' heavy traffic. 2500 w. Eng Rec—Jan. 27, 1912. No. 30065.

WATER SUPPLY

Bogota

Water Supply for the City of Bogota (Servicio de aguas de la ciudad de Bogota). M. J. Peña. Describes the various river resources. 1600 w. Anales de Ingenieria, Colombia—Dec., 1911. No. 30644 D.

Dam Failure

Failure of Austin Dam. J. W. Ledoux. A critical discussion of the construction of dams, especially the dam at Austin, Pa., that failed Sept. 30, 1911. Ills. 8500 w. Pro Engrs' Club of Phila—Jan., 1912. No. 30822 D.

Failure of a Low Concrete Dam Near Shippensburg, Pennsylvania. Charles E. Ryder. Illustrated account of a failure due to ice pressure, improper design and construction. 1700 w. Eng Rec—Feb. 17, 1912. No. 30467.

Dams

Provision for Uplift and Ice Pressure in Designing Masonry Dams. Continued discussion of the paper by C. L. Harrison. Ills. 8000 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30904 F.

The Design of Outlet Conduits for High Earth Dams. Winfield Holbrook. From *Univ. of Colo. Jour. of Engng.* Detailed discussion of important points in the design. 1400 w. Engng & Con—Jan. 24, 1912. No. 30102.

An Efficient Cheap Dam. H. D. Mendenhall. Illustrates and describes a type used successfully in the Florida pebble phosphate mining district. 1200 w. Eng News—Feb. 22, 1912. No. 30720.

An Automatic Dam Crest. F. F. Stickney. Illustrates and describes a crest automatically responsive to a sudden rise of water behind it. 1500 w. Eng News—Feb. 15, 1912. No. 30436.

The Largest Movable Wicket Dam. A. B. Reeve. Illustrated description of the Fernbank Dam on the Ohio River. 1000 w. Yale Sci M—Feb., 1912. No. 30851 C.

The Halligan Dam: A Reinforced Masonry Structure. Continued discussion of the paper by G. N. Houston. 1500 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30903 F.

The South Haiwee Earth Dam and Reservoir of the Los Angeles Aqueduct. J. B. Lippincott. Illustrated description of the construction. The earth fill, delivered in dump cars, is jetted to place by nozzle streams. 2000 w. Eng Rec—Feb. 3, 1912. No. 30252.

The Kachess Dam on the Yakima River in Washington. Describes an earth 60 ft. high and 1400 ft. long under construction as part of an irrigation project. 2200 w. Eng Rec—Jan. 27, 1912. No. 30068.

Arched Dams in New South Wales (Ueber ausgeführte Gewölbe-Talsperren in Neusüdwaes). Herr Ziegler. Analytic description of several thin arched dams. Ills. Serial. 1st part. 2200 w. Beton u Eisen—Jan. 3, 1912. No. 30554 D.

Ground Water

An Application of the Ground Water Theory to a Special Case (Applicazione della teoria delle falde idriche ad un caso speciale). C. Fossa-Mancini. Further discussion of the author's previous paper on this theory published Feb., 1910. Ills. 3700 w. Ann della Soc d Ing e d Arch Ital—Dec. 16, 1911. No. 30632 E.

Ice Troubles

Ice Trouble at the St. Louis Water Works. Edward E. Wall. Illustrated explanation of the cause, and remedy which averted serious trouble. 1200 w. Eng News—Feb. 1, 1912. No. 30236.

Irrigation

The Irrigation Situation. George M. Bull. Discusses irrigation developments in the western United States. 2500 w. Eng Rec—Feb. 24, 1912. No. 30737.

Irrigation Management. F. W. Hanna. Deals with the operation, rather than the maintenance or upkeep, of large irrigation systems. 2500 w. Eng News—Feb. 15, 1912. No. 30434.

Methods of Preparing Land and Applying Water for Irrigation. Considers prevailing practice in the United States. Ills. Engng & Con—Jan. 31, 1912. Serial. 1st part. No. 30146.

Methods of Preparing Land and Applying Water for Irrigation. Describes the

check method and the border method. 900 w. Engng & Con—Feb. 28, 1912. No. 30863.

Cost of Pumping Plant and of Pumping Water for Irrigation, Minidoka Project, U. S. Reclamation Service. Information from a paper by Barry Dibble, read before the Idaho Soc. of Engrs. 1000 w. Engng & Con—Jan. 24, 1912. No. 30101.

Development of Methods of Draining Irrigated Lands. C. G. Elliott. Considers methods and difficulties. Ills. 5000 w. U S Dept of Agri—Feb., 1912. (Reprint from June 30, 1910, report.) No. 30913 N.

Savage Irrigation in Luzon. Hamilton Wright. Illustrates and describes the wonderful rice terraces of the head-hunting Ifugaos. 1200 w. Sci Am—Feb. 3, 1912. No. 30203.

Irrigation in South Africa. W. A. Legg. Describes conditions and reviews irrigation development in the past and the possibilities of the future. Discussion. 12500 w. Jour Soc of Arts—Feb. 9, 1912. No. 30475 A.

Irrigation in South Africa. Editorial review of a paper by W. A. Legg, read before the Roy. Soc. of Arts. 1800 w. Engng—Feb. 2, 1912. No. 30405 A.

Large Irrigation Projects in the United States (Les grands travaux d'irrigation des États-Unis). Alex. Delisle. The first of the series of articles deals with the Roosevelt Dam and Reservoir project. Ills. Serial. 1st part. 8000 w. Génie Civil—Feb. 3, 1912. No. 30624 D.

Pipe Flow

Measuring the Flow of Water in Large Pipe Lines. R. M. Hosea. Illustrated description of a device and methods used at Pueblo, Colo. General discussion. 4500 w. Jour W Soc of Engrs—Jan., 1912. No. 30815 D.

Pipe Leakage

Leakage in Cast-Iron Water Pipe. E. G. Bradbury. Digest of a paper before the Ohio Engng. Soc. Information concerning the waste from this source. 3000 w. Eng Rec—Feb. 3, 1912. No. 30258.

Pipe Lines

Steel Siphons for New York's Water Supply. Illustrates and describes the supports, tests and coatings of the pipe line portions of the new water supply work. 600 w. Ir Age—Feb. 29, 1912. No. 30854 C.

Pollution

Pollution of the River Tame. John D. Watson. Condensed paper presented before the Nat. Assn. for Preventing Pollution of Rivers and Waterways of the U. S. Describes the pollution of this British river and the elaborate system for remedying the trouble. Map. 3500 w. Eng News—Feb. 8, 1912. No. 30356.

Purification

Pure Water and Its Relation to Health. J. W. Ellms. Explains what modern science defines as potable water, considers

water-borne diseases, methods of purification, filtration, etc. Ills. 4000 w. Jour Assn of Engng Socs—Jan., 1912. No. 30817 C.

Sterilizing by Anhydrous Chlorine. Abstract of paper by C. R. Darnall, read before the Am. Pub. Health Assn. Reports an investigation of the practicability of using chlorine in a gaseous form and the method employed. 2500 w. Munic Jour & Engr—Feb. 15, 1912. No. 30453.

Operation of the Kansas City Water Purification Plant. Reports results of treating Missouri River water. Ills. 1800 w. Eng Rec—Feb. 17, 1912. No. 30471.

The New Plant for the Purification of the Water Supply of Kansas City, Kansas. Illustrated description of works designed with particular attention to the clarification of the water by sedimentation and coagulation before filtration. 4500 w. Eng Rec—Jan. 27, 1912. No. 30064.

See also same heading under *Municipal*.

Reservoirs

Skating Rinks Above Water-Works Reservoirs, Reading, Penn. Mandes Golder. Brief illustrated description of use made of a covered reservoir. 600 w. Eng News—Jan. 25, 1912. No. 30090.

Two 4000000-Gallon Circular Reinforced Concrete Reservoirs at Brockton, Mass. Illustrates and describes methods of construction to insure impermeability. 1600 w. Eng Rec—Feb. 10, 1912. No. 30345.

See also Barge Canal, under *Waterways and Harbors*.

Siphons

The Syphon. Joseph Parker. Read before the Scottish Branch of the Nat. Assn. of Col. Mgrs. Deals with the natural philosophy of the syphon and applications of practical value. 2500 w. Ir & Coal Trds Rev—Feb. 2, 1912. No. 30413 A.

Standpipes

Standpipe Failure at Sheboygan, Wis. A statement of facts in regard to this failure, suggesting weak points in design which should be eliminated. Ills. 2000 w. Eng News—Feb. 1, 1912. No. 30235.

Valves

See same heading under *MECHANICAL ENGINEERING, Hydraulic Machinery*.

Water Power

See Water Power under *ELECTRICAL ENGINEERING, Generating Stations*.

WATERWAYS AND HARBORS

Barge Canal

Water Supply Projects in Connection with the New York State Barge Canal. W. G. Wildes. Illustrated description of the construction of the reservoirs at Hinckley, and at Delta, N. Y. 7000 w. Eng News—Feb. 15, 1912. No. 30433.

Canals

A Study of the "Clichy-Port-de-Mer" Project (Etude du Projet "Clichy-Port-de-Mer"). Ch. Lavaud. Description of the proposed canal between Rouen and

Clichy, and reports on similar canals elsewhere. Maps and tables. 52 pages. Mem Soc Ing Civ de France—Nov., 1911. No. 30592 D.

The Lock Gates of the Industrial and Commercial Harbor at Bremen-Oslebshausen (Die Schleusentore des Industrie- und Handelshafens zu Bremen-Oslebshausen). Ernst Overbech. Detailed description of the construction and operation of these gates. Ills. and plates. 8000 w. Zeitschr des Ver. deutscher Ing—Jan. 6, 1912. No. 30561 D.

Canal Systems on the Lower Bega (Die Kanalisierung der unteren Bega). Herr Pollak. Description of these Austrian Canals. 1800 w. Zeit d Oest Ing u Arch Ver—Jan. 26, 1912. No. 30538 D.

See also Barge Canal, under *Waterways and Harbors*.

Channels

Methods of Channel Protection with a Description and Costs of a Special Method Employed at Devil's Island, Illinois. F. Y. Parker. Ills. 1500 w. Engng & Con—Feb. 14, 1912. No. 30427.

Docks

Ore Dock at Cleveland, O. Illustrates and describes a plant including an ore dock, ore stock yard, railway yard, machinery for unloading, loading and for delivery of ore to stock piles. 3000 w. Eng News—Feb. 22, 1912. No. 30718.

Great Northern Ore Loading Dock at Allouez, Wis. Illustrated description of the new steel and concrete dock, near Superior, Wis., for handling very heavy tonnage. 2000 w. Ry Age Gaz—Jan. 26, 1912. No. 30088.

See also Dry-Docks under *MARINE AND NAVAL ENGINEERING*.

Drainage

Assessments for Benefits from Drainage Systems, for Agricultural and Sanitary Purposes. S. T. Morse. Outlines a system used under the laws of Illinois. 3500 w. Engng & Con—Feb. 21, 1912. No. 30714.

The Division of Costs in Relation to Drainage Systems. J. L. Parsons. A discussion of the underlying principles and explanation of a suggested system. 5000 w. Engng & Con—Jan. 24, 1912. No. 30103.

Construction and Maintenance of Open Drainage Ditches. G. P. Smith. Read before the Iowa Engng. Soc. Considers the proper construction, protection, and maintenance. 2000 w. Eng Rec—Feb. 10, 1912. No. 30351.

Mechanical Engineering Problems in the Drainage of River Bottom Lands. John J. Harman. Read before the Ill. Soc. of Engrs. & Survs. Considers important features of the problem of drainage by pumping. 2000 w. Engng & Con—Jan. 31, 1912. No. 30148.

Land Drainage by Means of Pumps. S. M. Woodward. Information on the effec-

tiveness of drainage reclamation, experience with drainage pumping methods, etc. Ills. 44 pages. U S Dept of Agri, Bul 243—Nov. 8, 1911. No. 30132 N.

Drainage Pumping Plant. H. L. Hutson. Considers the cost of pumping plant and its operation. 3000 w. Mfrs' Rec—Feb. 1, 1912. No. 30188.

A Report Upon the Back Swamp and Jacob Swamp Drainage District, Robeson County, North Carolina. Samuel H. McCrory, assisted by Carl W. Mengel. General description of the area and of the plan recommended, with related matters. Ills. 47 pages. U S Dept of Agri, Bul 246—Jan. 27, 1912. No. 30649 N.

Report on the Belzoni Drainage District in Washington County, Mississippi. H. A. Kipp. Describes the location and conditions, with plan for drainage, giving estimate of cost and results expected. Ills. 55 pages. U S Dept of Agri, Bul 244—Feb. 10, 1912. No. 30648 N.

See also Reclamation, under *Waterways and Harbors*.

Floods

Observations on the Seine at Paris during the Flood of January, February and March, 1911 (Observations faites sur la Seine a Paris pendant la Crue de Janvier-Fevrier-Mars 1911). M. Arana. Tables and calculations of the quantity of water flowing during this period of extraordinary flood. Plate. 8800 w. Ann des Ponts et Chaussées—Nov., 1911. No. 30596 E + F.

See also Track Reconstruction under *RAILWAY ENGINEERING, Permanent Way and Buildings*.

Jetties

How to Build a Stone Jetty on a Sand Bottom in the Open Sea. Continued discussion of the paper by Henry C. Ripley. 3500 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30905 F.

Panama Canal

Electric Power for the Panama Canal. John George Leigh. Considers the important applications of electricity in the construction and navigation. Ills. 1500 w. Elec Rev, Lond—Jan. 12, 1912. Serial. 1st part. No. 30295 A.

Mechanical Appliances on the Panama Canal. J. F. Springer. Discusses the character of the undertaking and the equipment, and the influence which the work has had on the apparatus used. Ills. 5500 w. Cassier's Mag—Feb., 1912. Serial. 1st part. No. 30288 B.

Panama Canal Dredge "Corozal." William G. Comber. Gives illustrated description with results of speed and endurance tests of the 1200-cu. yd. per hour ladder dredge. 2500 w. Eng News—Jan. 25, 1912. No. 30092.

The Panama Canal Shops at Balboa. Fred H. Colvin. Illustrates and describes these shops at the Pacific end of the canal, the machines used, and work. 2500 w. Am Mach—Feb. 8, 1912. No. 30273.

Keeping Shovels at Work at Panama. Fred H. Colvin. Illustrates and describes methods used to keep the steam shovels in repair so as to lose as little time as possible. 2000 w. Am Mach—Jan. 25, 1912. No. 30110.

Last Stages of the Panama Canal Construction. First of a series of descriptive articles of the final stages of canal construction, with special attention to the mechanical and other equipment provided for the operation and maintenance of safe navigation. Ills. 3000 w. Engr, Lond—Jan. 26, 1912. Serial. 1st part. No. 30326 A.

Reclamation

Land Reclamation by Flood Protection; a Typical Problem and Its Solution. Describes the Neosho River drainage area in Kansas as an example of the conditions encountered and works required. Map. 5000 w. Engng & Con—Feb. 28, 1912. No. 30864.

Wet Land Reclamation. Edward Wisner. A general survey of the work accomplished and future possibilities. 2000 w. Mfrs' Rec—Feb. 22, 1912. No. 30755 D.

Some Examples of Tidal Marsh Land Reclamation; Structures and Costs. First of a series of descriptions of specific works based on studies made by U. S. Government engineers. Ills. 1500 w. Engng & Con—Jan. 24, 1912. Serial. 1st part. No. 30100.

A Sandy Belt on the Madras Coast. Reginald Ryves. Illustrated description of the reclamation work, and its relation to Madras harbor works. 4500 w. Engr, Lond—Feb. 2, 1912. No. 30407 A.

Reclaiming of Minnesota's Swamp Lands: General Statement of Problem and of Progress of the Work. George A. Ralph. Ills. 5000 w. Engng & Con—Jan. 31, 1912. Serial. 1st part. No. 30147.

River Improvement

Government Improvement of the Upper Mississippi River. J. E. Kaulfuss. Information concerning the scope of the work. 3000 w. Wis Engr—Feb., 1912. Serial. 1st part. No. 30880 C.

Improvements Along the Rhone (Les Travaux d'Amélioration du Rhone). M. Armand. Discusses improved channel construction between Lyons and the sea. Plates. 22000 w. Ann des Ponts et Chaussées—Nov., 1911. No. 30595 E + F.

River Regulation

Notes on the Regulation of the River Nile. A. W. Robinson. Gives a brief account of the present stage of the engineering works carried out by the Irrigation Department. 5000 w. Can Soc of Civ Engrs—Feb., 1912. No. 30911 N.

Water Rights

New Plans in Prussian Water Legislation (Zum neuen Entwurf eines Preussischen Wassergesetzes). Herr Bitta. A discussion of the new rulings which affect

navigable streams and canals. 4900 w. Stahl u Eisen—Jan. 18, 1912. No. 30507 D.

Wharves

The Kansas City Municipal Wharf. Clark R. Mandigo. Illustrates and describes details of a wharf and wharf-house, equipped with freight handling machinery. 2500 w. Eng News—Jan. 25, 1912. No. 30091.

Light Reinforced-Concrete Wharfing Used in the Port of Madras. Francis Joseph Edward Spring. Describes conditions, the kinds of wharf now in use,

and the mode of erection. Ills. 1500 w. Inst of Civ Engrs, No. 3942. No. 30491 N.

MISCELLANY

United States

Engineering in United States in 1911. Reviews the notable features of the year in the different engineering fields. 2500 w. Engr, Lond—Feb. 9, 1912. Serial. 1st part. No. 30676 A.

West Africa

Engineering in the Tropics; West African Experiences. A descriptive letter from E. Blockley. 1800 w. Eng News—Feb. 22, 1912. No. 30722.

ELECTRICAL ENGINEERING

COMMUNICATION

Photo-Telegraphy

The Present State of Photo-Telegraphy (Der heutige stand der Bildtelegraphie). G. Eichhorn. Brief description of sending and receiving apparatus and some results. Ills. 3000 w. Oest Wochenschr f d Oeff Baudienst—Jan. 4, 1912. No. 30550 D.

Radiotelegraphy

Radio-Telegraphy. G. W. Osborn Howe. Explains the general principles underlying all systems, indicating the trend of improvements during the last few years. Ills. 7000 w. Jour Soc of Arts—Feb. 2, 1912. No. 30387 A.

Wireless Telegraphy on the Atlantic Coast of the United States. James L. Charlton. An outline of the wireless-telegraph development on the Atlantic coast line. Also editorial. 3000 w. Elec Wld—Jan. 27, 1912. No. 30104.

Ship's Telegraph

A New Electrical Ship's Telegraph Apparatus. Illustrates and describes an apparatus, due to Carl Meyer, using alternating current. 1000 w. Elec Rev, Lond—Feb. 9, 1912. No. 30658 A.

Telautograph

The Telautograph and Its Uses. H. J. Woods. Short descriptive paper, with discussion. Ills. 3000 w. Pro St. Louis Ry Club—Jan. 12, 1912. No. 30499.

Telephony

Calculations for 1000-Spark Frequency. Shunkichi Kimura. A mathematical study of high-pitch spark frequency and how to increase the spark potential. 2500 w. Elect'n, Lond—Jan. 26, 1912. No. 30298 A.

Railway Telephony in the United States of America. H. Marchand. Brief description of the system used. 3000 w. Bul Int Ry Cong—Feb., 1912 (2d part). No. 30892 G.

DYNAMOS AND MOTORS

Commutators

Single-Phase Commutator Motors. R. E. Hellmund and E. W. P. Smith. Pre-

sents facts regarding their design, showing the present tendency. Ills. 3000 w. Elec Jour—Feb., 1912. No. 30843.

The Theory of Current Reversal (Zur Theorie der Stromwendung). K. Pichel-mayer. Mathematical discussion. 2400 w. Elek u Masch—Jan. 7, 1912. No. 30519 D.

The Theory of Current Reversal (Zur Theorie der Stromwendung). F. Niet-hammer. Discussing previous paper by Prof. Pichelmayer. 1600 w. Elek u Masch—Jan. 21, 1912. No. 30523 D.

Compensators

Line Drop Compensators. E. F. Gehr-kens. Explains its function in an a. c. supply system. 3000 w. Gen Elec Rev—March, 1912. No. 30766 C.

Induction Motors

Practical Notes on Induction Motors. John S. Leese. Discusses their installation and maintenance. 3500 w. Elec Engr, Lond—Jan. 26, 1912. No. 30294 A.

A Simple Formula for Overloads in Three-Phase Induction Motors (Eine einfache Formel für die Ueberlastbarkeit des Drehstrominduktionsmotors). M. Vid-mar. Solution effected by means of circle diagram. 2500 w. Elek u Masch—Jan. 28, 1912. No. 30526 D.

Equalizer Reaction in Symmetrical Multi-Phase Motors (Ausgleichsvorgänge in der symmetrischen mehrphasenmaschine). L. Dreyfus. Mathematical discussion. Serial. 1st part. 5800 w. Elek u Masch—Jan. 14, 1912. No. 30521 D.

Railway Motors

Equipment for 1500-Volt D. C. Line of Piedmont Traction Company. The motors have forced draft and are connected two in series. Ills. 1500 w. Elec Ry Jour—Feb. 3, 1912. No. 30251.

Speed Regulation

Methods for Economical Speed Regulation of Three-Phase Motors. Dr. G. Meyer. Abstract trans. from *Elek Kraft und Bahnen*. Discusses means of varying the speed without loss and describes the several uses to which they can be applied.

3000 w. *Elect'n, Lond*—Feb. 2, 1912. Serial. 1st part. No. 30393 A.

Discussion on "Methods of Varying the Speed of Alternating-Current Motors." *New York, Dec. 8, 1911.* The paper by Gus A. Maier is discussed. 6000 w. *Pro Am Inst of Elec Engrs*—Feb., 1912. No. 30827 F.

The Speed Control of Large Induction Motors. N. Shuttleworth. Abstract of a paper before the Rugby Engng. Soc., dealing with the most important methods for changing the speed. Diagrams. 1500 w. *Engr, Lond*—Jan. 19, 1912. No. 30184 A.

A New Electric Reducing Gear. Dr. Max Breslauer. Illustrates and describes the "unipolar gear." 3000 w. *Elect'n, Lond*—Feb. 2, 1912. No. 30394 A.

Design of Motor Speed Regulators. In continuation of an earlier article particulars are given of the method of designing the speed regulators of direct-current motors. 1200 w. *Prac Engr*—Feb. 16, 1912. Serial. 1st part. No. 30791 A.

Wiring

Special Cases of Parallel Connection Treated Analytically (*Spezielle Fälle der Parallelschaltung in analytischer Behandlung*). J. Kuhn. Presenting several unusual cases and explaining most effective modes of treatment. 5000 w. *Elek u Masch*—Feb. 4, 1912. No. 30527 D.

ELECTRO-CHEMISTRY

Cells

Notes on the Chemistry of the Lead Cell. J. Horsnell May. Shows a need of an examination of the effect of impurities. 1200 w. *Elec Rev, Lond*—Jan. 19, 1912. No. 30153 A.

Corrosion

Contributions to the History of Corrosion. Arnold Philip. Read before the Inst. of Metals. Investigates the localized corrosion of condenser tubes by contact with electro-negative substances, and preventive methods. 3000 w. *Engng*—Jan. 19, 1912. Serial. 1st part. No. 30178 A.

The Corrosion of Condenser Tubes by Contact with Electro-Negative Substances. Arnold Philip. Read before the Inst. of Metals. Discusses especially localized corrosion occurring in condenser tubes made of Admiralty composition, and the problems yet to be solved. Also editorial. 3000 w. *Mech Engr*—Jan. 26, 1912. No. 30304 A.

See also Boiler Corrosion under MECHANICAL ENGINEERING, *Steam Engineering*.

Electric Furnaces

An Electric Furnace for Non-Ferrous Metals. Illustrated description of furnace invented by R. S. Wile, a combination of the arc and resistance types. 1000 w. *Ir Trd Rev*—Feb. 1, 1912. No. 30197.

Electroplating

A Few Pointers on Nickelplating. Seymour W. Rowsbar. Discusses the practical

side of electrodeposition of metals and other finishes. 2500 w. *Foundry*—Feb., 1912. Serial. 1st part. No. 30135.

Notes on the Electrodeposition of Black Nickel. Suggestions for working the solution successfully. 1000 w. *Brass Wld*—Feb., 1912. No. 30474.

Nitrogen

The Production of Nitric Acid from Atmospheric Nitrogen (*La Produzione dell'acido nitrico dall'azoto atmosferico*). E. Biffi. Describes electric apparatus and process. Ills. 2800 w. *Monit Tecnico*—Jan. 20, 1912. No. 30633 D.

Norway

Electro-Chemistry and Metallurgy in Norway. Thomas H. Norton. Information concerning these industries. 1800 w. *Min & Engng Wld*—Feb. 17, 1912. No. 30481.

ELECTRO-PHYSICS

Alternating Currents

Electric Potential in Alternating Magnetic Fields. C. F. Jenkin. Discusses the meaning of the term "Potential Difference" and the difficulty of measuring this quantity. 2000 w. *Elect'n, Lond*—Feb. 16, 1912. Serial. 1st part. No. 30789 A.

Reactance in Alternating Current Circuits. C. P. Steinmetz. Considers reactance as it affects the electric circuit, its objectionable and beneficial effects. Discussion. 9000 w. *Jour W Soc of Engrs*—Jan., 1912. No. 30816 D.

Disc-Machines

Direct Measurement of the Losses Due to Air Friction in Unipole-Disc Machines (*Direkte Messung der Luftreibungsverluste in Scheiben-Unipolarmaschinen*). B. von Ugrimoff and K. Schoenfer. Explains a theory for this determination. Ills. 1500 w. *Elek u Masch*—Feb. 4, 1912. No. 30528 D.

Double Frequency

A Static Frequency Duplicator. G. Vallauri. Abstract translation from the Italian. Diagrams and description of apparatus. 1000 w. *Elect'n, Lond*—Jan. 19, 1912. No. 30155 A.

Gravitation

An Electrophysical Explanation of Gravitation. Albert C. Crehore. An analysis of the cause of gravitation and comparison with the gravitational constant on the basis of corpuscular rotation. Also editorial. 6000 w. *Elec Wld*—Feb. 10, 1912. Serial. 1st part. No. 30382.

Induction Coils

The Theory of Induction Coils (*Zur Theorie des Funkeninduktors*). R. Hiecke. Presenting a theory of the electrical action in coils. 6800 w. *Elek u Masch*—Jan. 28, 1912. No. 30525 D.

Magnetic Properties

The Magnetic Transition Temperature of Cementite. S. W. J. Smith, W. White, and S. G. Barker. Determines the temperature at which cementite (carbide of iron) loses its ferromagnetism, and gives

examples to show the possibility of using the thermomagnetic properties of cementite to determine whether the substance is present in any iron-carbon alloy. 800 w. *Elect'n*, Lond—Feb. 9, 1912. No. 30682 A.

The Magnetic Properties of Nickel and Manganese Steels (Ueber die magnetischen Eigenschaften von Nickel- und Manganstählen). S. Hilpert, E. Colver-Glauert, and W. Mathesius. General data and results of experiments of varying grades. Ills. 5600 w. *Stahl u Eisen*—Jan. 18, 1912. No. 30508 D.

Spark Gaps

The Study of Spark Gaps with Alternating Currents (L'Étude des distances explosives avec les courants alternatifs). Considering the influences of humidity and temperature. Diagrams. 2000 w. *Génie Civil*—Jan. 27, 1912. No. 30623 D.

Tesla Coil

An Easily Constructed Tesla Coil. Alan S. Dana. Instructions for the amateur electrician. Ills. 1000 w. *Sci Am Sup*—Jan. 27, 1912. No. 30063.

GENERATING STATIONS

Accumulators

Alkaline Nickel-Iron Accumulators (L'Accumulateur alcalin fer-nickel). J. A. Montpellier. Presents advantages of the Edison and Gouin types over the lead accumulators. Two parts. 4800 w. *L'Électricien*—Jan. 20, 1912. No. 30606 D.

Central Stations

The Manufacture of Artificial Ice as a Central-Station By-Product. Sydney F. Walker. Describes ice-making processes that may be used in connection with electric central-station operation. 4000 w. *Elec Wld*—Feb. 3, 1912. No. 30263.

The First Long Distance Central Station in the Duchy of Luxemburg (Das erste Ueberlandkraftwerk in Grossherzogtum Luxemburg). J. P. Manternach. Describes plant and country operated over. Maps. 2400 w. *Elek Kraft u Bahnen*—Jan. 4, 1912. No. 30581 D.

Costs

The Relative Costs and Operating Efficiencies of Polyphase and Single-Phase Generating and Transmitting Systems. H. M. Hobart. A comparative study. 9500 w. *Pro Am Inst of Elec Engrs*—Feb., 1912. No. 30828 F.

A Method of Studying Power Costs with Reference to the Load Curve and Overload Economies. George I. Rhodes. Discusses the relation of load factor to operating power costs. 3500 w. *Pro Am Inst of Elec Engrs*—Feb., 1912. No. 30826 F.

Cost Figuring in an Electrical Plant. H. F. MacLane. Explains that part of cost keeping which deals with compiling the cost of the apparatus manufactured. 6000 w. *Am Mach*—Feb. 8, 1912. No. 30278.

Hydro-Electric

The Snell Hydroelectric Development on Raquette River, New York. Illus-

trated description of plant and construction where quality was considered before cost. 2000 w. *Eng Rec*—Feb. 17, 1912. No. 30464.

Water Power Development in Ohio. E. F. Baker. Information concerning five plants to be erected on the Maumee River and its tributaries. Ills. 1500 w. *Power*—Feb. 20, 1912. No. 30482.

New Hydroelectric Plant of Northern California Power Co. Rudolph W. Van Norden. Illustrated detailed description of the Coleman plant, part of a system delivering energy at 66,000 and 22,000 volts over nearly 400 miles of lines. 2500 w. *Elec Wld*—Feb. 3, 1912. No. 30262.

Developing Electrical Energy from the Los Angeles Aqueduct. Howard S. Knowlton. Illustrates and describes the plans for establishing a large hydroelectric system in connection with this new 23000000-dollar water system. 5500 w. *Elec Wld*—Feb. 10, 1912. No. 30381.

Water Power on the Los Angeles Aqueduct. Explains conditions affecting hydroelectric development at six stations. Map. 3000 w. *Eng Rec*—Feb. 3, 1912. No. 30255.

Hydro-Electric Installation in the Coeur d'Alenes. George Huston. Describes this mining region in Idaho, its stability, the power service, etc. Ills. 1800 w. *Min & Engng Wld*—Feb. 3, 1912. No. 30244.

Power System Cleveland Cliffs Iron Co. C. A. Tupper. Illustrated description of a hydraulic plant on the Carp River which will furnish power for mines on the Marquette range. 1000 w. *Eng & Min Jour*—Feb. 3, 1912. No. 30242.

The Power Plants of the Southern Indiana Power Company. DeWitt S. Moore. Read before the Indiana Engng. Soc. Illustrates and describes a hydroelectric power plant having a steam auxiliary plant as a reserve. 3000 w. *Eng Rec*—Feb. 10, 1912. No. 30350.

The Hydroelectric Plant at Marseilles. Illustrated description of a development in Illinois, where every inch of head had to be considered. 2200 w. *Eng Rec*—Feb. 24, 1912. No. 30732.

Water-Power for Coal Mines. Illustrates and describes the development of the Appalachian Power Co. in S.W. Virginia. Map. 3000 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30757 D.

See also Water Power, under *Generating Stations*.

Isolated Plants

Cost of Power Generated in Isolated Plants. Gives analysis of the cost of generation by non-condensing engines where the exhaust steam is used for heating during the winter season. 1500 w. *Ir Age*—Feb. 15, 1912. No. 30416.

Hebrew Infant Asylum Power Plant. Warren O. Rogers. Illustrated description of a small modern isolated plant. 1800 w. *Power*—Feb. 27, 1912. No. 30781.

Load Equalization

The Use of Batteries on Alternating Current Systems. Considers the question of load equalization from the alternating current central station engineer's standpoint. Ills. 2800 w. Engr, Lond—Feb. 16, 1912. Serial. 1st part. No. 30801 A.

Load Factors

Central Station Load Factors. E. F. Tweedy. Shows the desirability of railway, ice-making, and other loads to utilize the generating equipment. 2200 w. Elec Wld—Feb. 3, 1912. No. 30266.

Power Plants

Power System of the Pacific Mills, Methods and Rules for, and Cost of Operation. Fred A. Wallace. Illustrated description of the recently installed system at North Lawrence, Mass., which supplies electric current for power and light to these mills. Discussion. 15500 w. Jour Assn of Engng Socs—Jan., 1912. No. 30818 C.

Plant of Capital Traction Company. J. H. Beattie. Illustrated detailed description of the new plant in Washington, D. C., just completed. 1500 w. Power—Feb. 13, 1912. No. 30384.

Modern Power Plants in Florida Phosphate District. C. A. Tupper. Illustrates and describes gas-engine plants and Diesel oil engines driving Bullock generators. 2000 w. Min & Engng Wld—Feb. 3, 1912. No. 30246.

The Chamber Hall Power Station, Bury. Illustrated detailed description of this new station. 2500 w. Engr, Lond—Feb. 9, 1912. No. 30678 A.

Electric Power Station at Bahia Blanca. Illustrated description of a recently completed plant in Argentine Republic for supplying electrical energy for public and private lighting, tramways, work-shops and wharves. 3500 w. Engr, Lond—Feb. 16, 1912. No. 30800 A.

Plants of the Bernese Power Co. (Anlagen der Bernischen Kraftwerke A.-G.). Hydroelectric plants supplying power to the Lötschberg Ry., etc., and situation in the Kander valley. Ills. and Maps. Serial. 1st part. 1500 w. Schweiz Bau—Jan. 6, 1912. No. 30540 D.

Public Utilities

Some Criteria of Value in Public-Service Industries. Clarence P. Fowler. Analytical review of investment data of electric light and power undertakings. 9500 w. Engineering Magazine—March, 1912. No. 30830.

Rates

Diversity-Factor and Fixed Charges. Renzo Norsa. Discusses the problems of diversities. 5000 w. Elec Rev & W Elect'n—Dec. 23, 1911. No. 28905.

Low Rates and the Development of the Central-Station Service. W. E. Burnand. A suggested schedule involving central-station control of customers' meters. 3000 w. Elec Wld—Feb. 3, 1912. No. 30267.

The Earning Power of Long Distance Central-Stations (Die Rentabilität von Ueberlandzentralen). Fr. Kesselring. Presenting tables of comparative costs of production and profits of various power companies. 4400 w. Elek u Masch—Jan. 21, 1912. No. 30522 D.

Rural Stations

Rural and Domestic Applications of Electricity. Frank Koester. Illustrated account of uses made of electricity on farms in Germany, Italy and other foreign countries. 1500 w. Elec Rev & W Elect'n—Feb. 10, 1912. No. 30379.

Statistics

Statistics of Electric Power Plants in Holland for the Year 1910 (Statistiek van Electriciteitsbedrijven in Nederland voor 1910). Giving size, motive power, system, etc., of all plants in Holland. 23 pages. Ingenieur—Jan. 6, 1912. No. 30590 D.

Switchboards

Switchboard Panels for Three-Wire Generators. A. M. Bennett. Gives various methods of connections, explaining the economic and practical advantages of each. Diagrams. 2000 w. Elec Wld—Feb. 3, 1912. No. 30264.

Water Power

Principles of Water-Power Development. W. J. McGee. Discusses the great national importance of this issue. 2500 w. Sci Am Sup—Feb. 3, 1912. Serial. 1st part. No. 30204.

Water-Power Projects in New York. An abstract of the report of the N. Y. State Committee submitted to the Legislature. 2500 w. Eng News—Feb. 1, 1912. No. 30237.

LIGHTING**Car Lighting**

See same heading, under MECHANICAL ENGINEERING, *Automobiles*.

Illumination

Graphs of Certain Relations in Industrial Lighting Economics. Roscoe Scott. Gives charts, with explanation of their construction and use. 2200 w. Elec Wld—Feb 10, 1912. No. 30383.

Incandescent Lamps

Special Phenomena Accompanying the Rupture of Incandescent Filament in Mixtures of Air and Combustible Gases (Phénomènes spéciaux accompagnant la rupture des filaments incandescents dans les mélanges d'air et de gaz combustibles). H. Couriot and J. Meunier. Interesting experiments for the laboratory. Ills. 4000 w. Génie Civil—Jan. 20, 1912. No. 30618 D.

Metallic Arcs

Some Observations on the Metallic Arc. G. M. Little. A report of investigations and results. Ills. 3000 w. Elec Jour—Feb., 1912. No. 30846.

Photometry

Some Factors in Heterochromatic Photometry. Louis Bell. Calls attention to a frequent source of error in comparing

lights differing in color, reporting experiments. Ills. 3000 w. Elec Wld—Jan. 27, 1912. No. 30105.

Rectifiers

The Operation of Mercury Arc Rectifiers. Q. A. Brackett. Describes briefly the manner in which a rectifier bulb operates, and its use for battery charging. Ills. 4000 w. Elec Jour—Feb., 1912. No. 30844.

Vacuum Tubes

Special Energy Distribution of Neon and Helium. W. W. Coblentz. On progress in vacuum tube illuminants. 1200 w. Elec Wld—Feb. 17, 1912. No. 30488.

MEASUREMENT

Calculator

A Vector Calculator. F. Addey. Explains a calculator used for telephone calculations, and similar problems. 500 w. Elec Rev, Lond—Jan. 26, 1912. No. 30296 A.

Generator Tests

Short Circuit Tests of a 12,000 KW. 9,000 Volt 25 Cycle Turbo-Generator with External Reactance Coils. Rudolf Fredrick Schuchardt. States the points to be determined and describes tests. Ills. 2500 w. Wis Engr—Feb., 1912. No. 30879 C.

High Frequency

The Distribution of Current and the Variation of Resistance in Linear Conductors of Square and Rectangular Cross-Section When Carrying Alternating Currents of High Frequency. H. W. Edwards. Abstract of an article in the *Phys. Rev.* Discusses the experimental method adopted. 1800 w. Elect'n Lond—Feb. 9, 1912. No. 30681 A.

Insulation

High-Voltage Tests and Energy Losses in Insulating Materials. E. H. Rayner. Abstract of paper before the Inst. of Elec. Engrs. Describes experiments made to discover the effect on the electric strength of materials of applying for some time a voltage that is 30 to 90 per cent of that which will produce a breakdown in a few seconds. 4000 w. Elect'n, Lond—Feb. 9, 1912. Serial. 1st part. No. 30680 A.

Instruments

The Selection of Electrical Apparatus. H. M. Phillips. An investigation of conditions governing capacity. 3500 w. Casier's Mag—Feb., 1912. No. 30282 B.

Meters

Notes on the Constancy of Integrating A. C. Meters in Relation to Road and Railway Transport. Describes tests made to determine whether supply meters are detrimentally effected by travelling by road or rail. 1500 w. Elect'n, Lond—Feb. 2, 1912. No. 30392 A.

Sangamo Ampere-Hour and Watt-Hour Meters. Joseph B. Baker. Illustrated detailed description. 1500 w. Elec Rev & W Elect'n—Feb. 24, 1912. Serial. 1st part. No. 30774.

Photometry

See same heading, under *Lighting*.

Power-Factor

Power-Factor Correction by Rotary Converters Is Hazardous. Nicholas Stahl. Shows the danger involved in attempting over-excitation and indicates the limitations of the method. 1500 w. Elec Jour—Feb., 1912. No. 30845.

POWER APPLICATIONS

Agriculture

Electricity as a Factor in Progressive Agriculture. E. P. Edwards. Read before the N. Y. Elec. Soc. Considers the possible and probable advantages to be expected from the use of electricity by the agricultural community. 4000 w. Mfrs' Rec—Feb. 8, 1912. No. 30329.

Electric Motors for the Operation of Farm Machinery. Frank Koester. Illustrates and describes various applications. 4500 w. Elec Rev & W Elect'n—Feb. 24, 1912. No. 30773.

Electricity in Agriculture (Die Elektrizität in der Landwirtschaft). Herr Kareis. Presenting some of the advantages electric power has over other motors on the farm. Serial. 1st part. 1000 w. Elektrotechniker—Jan. 25, 1912. No. 30532 D.

Electrical Machinery

The Heat Paths in Electrical Machinery. Harold D. Symons and Miles Walker. Deals with methods of predetermining the temperature rise in electrical machinery, with an account of experiments. Ills. 12000 w. Inst of Elec Engrs—Jan. 25, 1912. No. 30297 N.

Notes on National and International Standards for Electrical Machinery. Dr. Robert Pohl. Read before the Inst. of Elec. Engrs. A discussion of the subject and its importance, with suggestions. 10500 w. Engng—Jan. 26, 1912. No. 30322 A.

Electricity in Armor Plating Shops (Die Elektrizität in Werkstätten für Blech- und Panzerplattenbearbeitung). O. Pollok. Some of the powerful machines in this heavy work described. Ills. 4500 w. Stahl u Eisen—Feb. 1, 1912. No. 30512 D.

Excavators

See same heading, under *CIVIL ENGINEERING, Construction*.

Mills

Electric Power in Flour and Grist Mills. Gives results of many tests showing what results may be expected under various conditions. Ills. 5000 w. Elec Rev & W Elect'n—Feb. 17, 1912. No. 30652.

Mining

See Electric Power, under *MINING AND METALLURGY, Mining*.

N. Y. Library

The Electrical Equipment of the New York Public Library. M. C. Turpin. Brief illustrated description of the generating and heating equipment and motor

applications. 2500 w. Elec Jour—Feb., 1912. No. 30842.

Panama Canal

See same heading, under CIVIL ENGINEERING, *Waterways and Harbors*.

TRANSMISSION

Corona Losses

Experiments on the Losses Due to Corona on Transmission Lines. H. Görges, P. Weidig, and A. Jaensch. Trans. from *Elek. Zeit.* Describes experimental work to determine corona losses at high pressure on transmission lines. 1500 w. Elect'n, Lond—Feb. 2, 1912. No. 30391 A.

Lighting

The Ground Connection in Lighting Protective Systems. E. E. F. Creighton. From an article in the *Gen. Elec. Rev.* Instructions for making connections, etc. 2500 w. Elec Rev & W Elect'n—Feb. 17, 1912. No. 30653.

Lines

Artificial Power-Transmission Line. A. E. Kennelly and H. Tabossi. Describes constructive details and results of tests of a 1,500-mile single-phase artificial transmission line built for experimental purposes. Ills. 1800 w. Elec Wld—Feb. 17, 1912. No. 30487.

A Machine for the Calculation of Supply Networks. J. Nowak. Abstract translation from *Elektrotechnische Zeit.* Describes a machine for determining the currents in the various cables, and the pressure-drops from feeding-point to junction and from one junction to another. Ills. 2500 w. Elect'n, Lond—Feb. 16, 1912. No. 30788 A.

Lines for Current Collectors in Electric Railways (La Ligne de Prise de Courant dans les Chemins de fer électriques). Gustav L'Hoest. Discusses third rail, single and double catenary, bipolar, and other systems of conveyors. Ills. 6600 w. Soc Belge des Elec—Dec., 1911. No. 30600 E.

Poles

Wood and Concrete Poles in Electrical Service. W. Manktelow. The present article is devoted mainly to a discussion of

wooden poles. Ills. 2500 w. Elec Rev, Lond—Feb. 2, 1912. No. 30390 A.

Substations

Substation of the Jamestown (N. Y.) Lighting and Power Company. Illustrates and describes changes in generating equipment. 1000 w. Elec Wld—Feb. 24, 1912. No. 30775.

Transformer Oils

The Formation of Deposit by Transformer Oils. P. N. Hooper. Report of investigations of the Newcastle Electric Supply Co., with comments on results reported by Mr. Symons, published in Dec. 22d and 29th issues. 3500 w. Elec Rev, Lond—Feb. 16, 1912. No. 30787 A.

Transformers

The Transformation of Electric Energy. Abstract translation of a lecture by Leo Scholer. Illustrates and describes machines used. 1500 w. Ir & Coal Trds Rev—Feb. 2, 1912. No. 30414 A.

Heat Tests of Alternate-Current Transformers. J. T. Morris, J. W. Elliott, and D. Lewes. A report of experimental researches, and results, made to examine how nearly the heating of the various parts of a c. transformers follows an exponential law. 1500 w. Elect'n, Lond—Jan. 26, 1912. No. 30299 A.

Instrument Transformers and Their Compensation. Harold A. Cooch. Considers transformers for meter service. 1200 w. Ap Sci—Feb., 1912. No. 30885 C.

The Construction of Constant Current Transformers. L. Arnold. Describes standard construction. Ills. 2200 w. Gen Elec Rev—March, 1912. No. 30768 C.

MISCELLANY

Expositions

International Exposition of Industry and Labor, Turin, 1911 (Esposizione Internazionale delle Industrie e del Lavoro, Torino 1911). Elvio Soleri. The first of the series treats of the electrical machinery on exhibition from various European countries. Ills. Serial. 1st part. 3700 w. Industria—Jan. 7, 1912. No. 30635 D.

INDUSTRIAL ECONOMY

Agriculture

The Increase of Agricultural Efficiency. Oskar Nagel. Considers briefly artificial stimulus and nourishment for plants. 1500 w. Cassier's Mag—Feb., 1912. No. 30285 B.

See same heading, under ELECTRICAL ENGINEERING, *Power Applications*.

Apprenticeship

Modern Apprenticeship. A. D. Williams. Critical discussion of systems. 1800 w. Sib Jour of Engng—Jan., 1912. No. 30825 C.

Machinist Trade Apprenticeships. Charles H. Winslow. A discussion of developments of industrial education, outlining a three-year machinist apprenticeship course and schedule of equipment necessary. 6500 w. Am Mach—Jan. 25, 1912. No. 30113.

Chemistry

The Earning Power of Chemistry. Arthur D. Little. Lecture under the auspices of the Indiana Sec. of the Am. Chem. Soc. Explains the many benefits for which the world is indebted to this sci-

ence. Its industrial value is shown. 4500 w. *Sci Am Sup*—Jan. 27, 1912. No. 30062.

The Progress in Chemical Industry of the South. David T. Day. Considers past and future development. 3500 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30743 D.

Cost Methods

Cost Methods that Give the Executive Control of His Business. Benjamin A. Franklin. This third article discusses the cost of the salable article. 3000 w. *Engineering Magazine*—March, 1912. No. 20834 B.

Education

The Efficiency Principles of Technical Education. Julian C. Smallwood. Urging an efficiency basis for evaluating the work. 3500 w. *Engineering Magazine*—March, 1912. No. 30833 B.

Shall I Give My Boy a Technical Education? John Ritchie, Jr. First of a series of articles discussing the advantages and requirements of various technical professions. 1500 w. *Sci Am*—March 2, 1912. Serial. 1st part. No. 30916.

The Cincinnati Method of Industrial Education—A Friendly Criticism. James A. Pratt. Discusses points favorable and unfavorable to this plan. 2500 w. *Mach, N Y*—March, 1912. No. 30923 C.

Advanced Courses in Electrical Engineering. Ernst J. Berg. Abstract of a series of lectures, illustrated by problems, given at the University of Illinois. 2500 w. *Gen Elec Rev*—March, 1912. Serial. 1st part. No. 30765 C.

The Training of Mine Officials. George Knox. From a paper read before the Wigan and Dist. Inst. of Min. Students. Discusses the aims of the technical mining school, and the required training for colliery officials. 2500 w. *Col Guard*—Jan. 19, 1912. No. 30171 A.

A Swiss Works Continuation School. Describes the Sulzer Bros.' school for training apprentices, outlining the courses of study and other details. 3000 w. *Am Mach*—Feb. 22, 1912. No. 30688.

Industries

Work, and the Elements that Enter Into the Building Up of an Industrial Enterprise. John Edson Sweet. 2500 w. *Sib Jour of Engng*—Jan., 1912. No. 30824 C.

Labor

A System of Employing Labor. Explains a scheme of operation of an employment bureau of manufacturers of Racine, Wis. 1400 w. *Ir Age*—Feb. 29, 1912. No. 30853 C.

Hours and Intensity of Steel Works Labor. Sidney G. Koon. A study showing the hours of hard work are fewer than represented. 1200 w. *Ir Age*—Feb. 1, 1912. No. 30195 C.

Government Work Shop Management. W. S. Peirce. Discusses the arsenal la-

bor troubles from the official side. 5000 w. *Ir Age*—Feb. 22, 1912. No. 30705 C.

The Rock Island Arsenal Labor Trouble. Max H. C. Brombacher. Critical discussion of the trouble and the attack on scientific management. 2500 w. *Ir Age*—Feb. 1, 1912. No. 30194 C.

The History of Famous Strikes. T. M. Prudden. Brief review of important strikes and their results. 3500 w. *Yale Sci M*—Feb., 1912. No. 30848 C.

Management

The Efficiency Movement in the Foundry. C. E. Knoepfel. Read before the Am. Found. Assn. A discussion of the application and economics of scientific management in the casting shops. 4500 w. *Foundry*—Feb., 1912. No. 30134.

The Practical Application of Scientific Management to Railway Operation. Continued discussion of the paper by Wilson E. Symons. 12000 w. *Jour Fr Inst*—Feb., 1912. No. 30703 D.

Elementary Time Study as a Part of the Taylor System of Scientific Management. H. K. Hathaway. An exposition of the principles and methods upon which scientific management is based. 8000 w. *Ind Engng*—Feb., 1912. No. 30443 C.

Mining Profits

Profit and Safety in Mining. Henry Briggs. Presidential address to the Eastern Branch of the Scottish Fed. Inst. of Min. Students. Discusses the use of machinery where the price of labor is high, and whether mining is getting safer. 4600 w. *Ir & Coal Trds Rev*—Feb. 9, 1912. No. 30683 A.

Organization

Modern Organization. Charles DeLano Hine. This third article of a series considers critically the present practice, discussing the problem of restoring balance. 1500 w. *Engineering Magazine*—March, 1912. No. 30829 B.

Taylor's Success in the Principles of Factory Organization (Taylors Erfolge auf dem Gebiete der Fabrikorganisation). A. Wallich. Description of F. W. Taylor's principles in scientific management in the factory. Diagrams. 2000 w. *Stahl u Eisen*—Jan. 11, 1912. No. 30504 D.

Public Utilities

See same heading, under ELECTRICAL ENGINEERING, *Generating Stations*.

Wages

American and European Wages and Efficiency. William L. Saunders. Observations on a recent trip around the world. Considers Germany the most formidable competitor. 1800 w. *Ir Age*—Feb. 29, 1912. No. 30855 C.

Welfare Work

Welfare Work of a Large Manufacturing Company. Hamilton A. Rogers. An illustrated account of the work of the Westinghouse Electric & Mfg. Co. for their employees. 2000 w. *Elec Jour*—Feb., 1912. No. 30847.

MARINE AND NAVAL ENGINEERING

Battleships

Modern Battleship Armament. Charles F. Clise. Considers some of the present-day problems in this field. 2000 w. Yale Sci M—Feb., 1912. No. 30850 C.

Essential Armament and Sub-Surface Protection in Battleships (Armamento principale e difesa subaquea delle navi da battaglia). S. Orlando. Takes up the ideas of modern battleship construction especially of the "Dreadnought" type. Ills. 14000 w. Rivista Marittima—Dec., 1911. No. 30641 E + F.

The Battleship Cruiser "Lion" of the British Navy (Le cuirassé-croiseur "Lion" de la Marine britannique). M. Gouriet. Brief description of this recent addition to the British Navy. Ills. 3000 w. Génie Civil—Jan. 20, 1912. No. 30617 D.

Boilers

The Evolution of the Scotch Marine Boiler. Sinclair Couper. From *The Engng. Rev.* Traces the evolution of this boiler from the types that preceded it, showing its development. Ills. 3500 w. Boiler Maker—Feb., 1912. No. 30343.

Collisions

The Hawke-Olympic Collision. Percy A. Hislam. Illustrates and describes the investigation made by towing models of the two ships in a towing tank to determine the effects of vessels upon each other when steaming on parallel courses in close proximity. 1500 w. Sci Am Sup—Feb. 24, 1912. No. 30740.

Cranes

Recent Giant Cranes in Ship Yards (Neue Riesenkrane für Schiffswerften). Brief description of some new types. Ills. 2000 w. Schiffbau—Jan. 10, 1912. No. 30586 D.

120-Ton Double Floating Crane for the Austrian Navy Yard at Pola (Grue flottante double de 120 tonnes des chantiers navals de Pola-Autriche). M. Gerard. Details and plans of its construction. Ills. and Plate. 1500 w. Rev Industrielle—Jan. 20, 1912. No. 30630 D.

Diesel Engines

Diesel Engines. Sir J. Fortescue Flannery. Considers their advantages. 2500 w. Marine Rev—Feb., 1912. No. 30428.

The Carels Diesel Marine Engine. Illustrates and describes an engine of the two-cycle single-acting type capable of burning the heaviest oils on an economical consumption. 1000 w. Engng—Jan. 19, 1912. No. 30175 A.

A Slipping Clutch for Diesel Marine Engine Installations. Illustrates and describes the Koreiwo clutch widely used in Russia. 1500 w. Int Marine Engng—Feb., 1912. No. 30213 C.

100-Shaft-Horse-Power Reversible Diesel Marine Engine. Illustrated description of engines working on the two-cycle principle for ship propulsion. 1500 w. Engng—Feb. 16, 1912. No. 30798 A.

The Application of the Diesel Engine to the Propulsion of Large Steamships (Die Verwendung von Dieselmotoren zum Antrieb von grösseren Seeschiffen). W. Kaemmerer. Cites examples of present usage on large vessels, with the necessary modifications. Ills. Serial. 1st part. 4500 w. Zeitschr des Ver deutscher Ing—Jan. 20, 1912. No. 30567 D.

Dockyards

Engineering Works at the Rosyth Naval Dockyard. Illustrated detailed description of the important works in progress on the Firth of Forth, involving an expenditure of between £3,000,000 and £4,000,000. Plates. 10500 w. Engng—Jan. 19, 1912. Serial. 1st part. No. 30172 A.

Dredges

See Panama Canal, under CIVIL ENGINEERING, *Waterways and Harbors*; and Dredges, under MINING AND METALLURGY, *Gold and Silver*.

Dry-Docks

Twenty Thousand-Ton Pontoon. Floating Dry-Dock. Drawings and description of the dry-dock for the marine terminal of the Grand Trunk Pacific Ry. at Prince Rupert, B. C. 2500 w. Int Marine Engng—Feb., 1912. No. 30211 C.

Electric Power

The Use of Alternating Current from the Electric Plant on Board (Sull' Impiego della Corrente Alternata negli Impianti Elettrici di Bordo). Marco Viani. Presents views on the advantages obtained from alternating currents. 8000 w. Rivista Marittima—Jan., 1912. No. 30642 E + F.

Engines

See Templets, under MECHANICAL ENGINEERING, *Machine Elements and Design*.

Fishing Vessels

Large Steam Fishing Vessels with Refrigerating Plants (Die Grössengrenze für Fischdampfer mit kühlanlage). P. Knipping. Details of construction. Ills. 3600 w. Schiffbau—Jan. 24, 1912. No. 30587 D.

Gas Engines

Sea-Going Gas-Driven Cargo Vessel. The gas engine cargo boat Holzappel I is illustrated and the machinery equipment described. 2000 w. Engr, Lond—Feb. 16, 1912. No. 30802 A.

Naval Schools

Notes on the Naval Schools of France and Other Countries (Considerations sur l'école navale en France et a l'étranger). Comparisons between the naval school

systems of various countries. Serial. 1st part. 1800 w. *Le Yacht*—Jan. 27, 1912. No. 30626 D.

Navy Yards

The Imperial German Navy Yard at Tsingtau (Die Kaiserlich deutsche Werft zu Tsingtau—Kiauschou). Description of this yard for repairs, etc. Ills. 2400 w. *Schiffbau*—Jan. 24, 1912. No. 30588 D.

Oil Engines

A Thirty-Day Non-Stop Run of a Marine Oil Engine. A report of a trial made by Barclay, Curles & Co., Ltd. and the very satisfactory results. 2200 w. *Engr*, Lond—Jan. 26, 1912. No. 30327 A.

The Nuremberg Marine Oil-Engine. Considers recent developments and applications of this type, giving illustrations and a description of the features in which the Nuremberg type differs from others. 3000 w. *Engng*—Feb. 9, 1912. No. 30669 A.

Oil-Engined Ships "Selandia" and "Jutlandia." Describes the first oil-driven ships built for regular passenger service, especially considering the machinery. 2000 w. *Engng*—Feb. 23, 1912. No. 31040 A.

See also Diesel Engines, and Gas Engines, under MARINE AND NAVAL ENGINEERING.

Progress

Progress in Marine Engineering During the Past Fifteen Years. Dr. W. F. Durand. Considers the more important features that have marked the progress in this field. 12000 w. *Int Marine Engng*—March, 1912. No. 30998 C.

Propellers

Note on the Screw Propeller. H. A. Mavor. An argument for referring propeller experiments to a common standard of comparison; for considering the efficiency of propellers in terms of their efficiency as pumps; and for making experiments on the propeller on the moored ship to determine its efficiency as a pump. 6000 w. *Trans Inst of Engrs & Shipbldrs* in Scotland—Dec. 19, 1911. No. 30897 N.

See also Propeller Design, under MECHANICAL ENGINEERING, *Machine Elements and Design*.

Salving

The Salving of the Submarine Boat A-3. Discusses the question of salving this submarine sunk by collision with the gunboat Hazard. Ills. 800 w. *Engng*—Feb. 16, 1912. No. 30799 A.

Shipbuilding

The World's Naval and Merchant Shipbuilding. Reviews information from the last issue of Lloyd's Register. 3000 w. *Engng*—Jan. 19, 1912. No. 30174 A.

Ship's Telegraph

See same heading, under ELECTRICAL ENGINEERING, *Communication*.

Soundings

A Comparison of Four Methods of Making Soundings. Myron H. Peck. Describes

and compares methods used in connection with work near San Francisco. 2500 w. *Eng News*—Feb. 22, 1912. No. 30721.

Speed

The Economical Speed of Ships. George Harrison. Discusses the relations between power, speed and cost. 2000 w. *Cassier's Mag*—Feb., 1912. No. 30286 B.

Stabilizers

A Further Note on Approximate Stability. Arthur R. Liddell. Considerations relating to the stability conditions of vessels. 2000 w. *Engr*, Lond—Feb. 23, 1912. No. 31046 A.

Automatic Longitudinal Stabilizers for Submersibles (Per assicurare automaticamente la stabilità longitudinale dei sommergibili). G. Manetti. A new device for the purpose. Ills. 3200 w. *Rivista Marittima*—Jan., 1912. No. 30643 E + F.

Steamships

A Retrospect of Fifteen Gears of Ship Design and Construction. C. H. Peabody. A review of the contest for maritime supremacy on the N. Atlantic. 7000 w. *Int Marine Engng*—March, 1912. No. 30997 C.

The Cunard Liner Laconia. Illustrated description of this large steamship which recently made its maiden voyage. Plates. 1500 w. *Engr*, Lond—Jan. 26, 1912. No. 30324 A.

New Menhaden Steamers for the Atlantic Coast. Martin C. Erismann. Illustrated description of three fishing boats just put in service. 1600 w. *Int Marine Engng*—Feb., 1912. No. 30214 C.

The Italian Turbine Passenger Steamer Citta di Palermo. Dagnino Attilio. Brief illustrated description. 700 w. *Int Marine Engng*—Feb., 1912. No. 30210 C.

Submersibles

The Laurenti Submersible Boat "Hvalen" for the Swedish Navy. Photographs and description of this boat, of especial interest because of placing of orders for the British and Brazilian Navies and the propulsion by F. I. A. T. oil engines. 700 w. *Engng*—Jan. 19, 1912. No. 30176 A.

Tank Steamers

New Tank Steamer for the Gulf Refining Company. Information concerning a new steamer to be known as the Gulf-oil. Ills. 1500 w. *Int Marine Engng*—March, 1912. No. 30999 C.

Torpedo-Boat

The Danish Torpedo-Boat "Soridderen." Plate and brief description. 700 w. *Engng*—Jan. 26, 1912. No. 30318 A.

Turbines

See same heading under MECHANICAL ENGINEERING, *Steam Engineering*.

Turret Ships

The Jubilee of the Turret-Ship. Percival A. Hislam. Reviews the progress of the turret-ship during fifty years. Ills. 1800 w. *Sci Am*—Feb. 17, 1912. No. 30440.

MECHANICAL ENGINEERING

AERONAUTICS

Aerodynamics

See Hydrodynamics under *Hydraulic Machinery*.

Aeromechanics

Elements of Theoretical Aëromechanics. A. F. Zahm. The present article presents principles of aërostatics. 2500 w. Jour Fr Inst—Feb., 1912. Serial. 1st part. No. 30702 D.

Balloons

The Wire-wound Dirigible Balloon. Illustrates and describes the design of a new wired-fabric airship under construction for Mr. Vaniman. 1200 w. Sci Am—Feb. 17, 1912. No. 30439.

Expositions

The Third Aeroplane Show at Paris (Die Flugzeuge im dritten Pariser Salon). L. Szkolnik. Description of the exhibition with diagrams of some of the leading features presented. Ills. Serial. 1st part. 1500 w. Motorwagen—Jan. 31, 1912. No. 30534 D.

Military

Military Aviation (Aviacion Militar). F. Cervantes. A brief résumé of the history of aviation especially in its application to military purposes, from the early scout balloons to the modern aeroplane. Ills. 2500 w. Boletin de Ingenieros, Mex.—Jan. 16, 1912. No. 30645 N.

Notes on Launching Projectiles from Aeroplanes (Considerations sur le lancement des projectiles par les aeroplanes). J. Olive. Studies on the trajectory path from moving planes. Ills. 4500 w. Génie Civil—Jan. 13, 1912. No. 30616 D.

Motors

New Aeroplane Motors at the Paris Show. Illustrates and describes the principal types exhibited. 1500 w. Sci Am Sup—Feb. 3, 1912. No. 30209.

Propellers

The Cynos Rotating Wings (L'aile rotative Cynos). E. Friedheim. Describes the theory and design of these novel propellers. Ills. 2500 w. Rev Industrielle—Jan. 20, 1912. No. 30629 D.

Trans-Atlantic Flights

Across the Atlantic by Aeroplane. James V. Martin. Discusses the problem and offers suggestions for its solution. Ills. 2500 w. Sci Am—Feb. 3, 1912. No. 30202.

AUTOMOBILES

Ball-Bearings

See same heading under *Machine Elements and Design*.

Calthorpe

The 15 h.p. Calthorpe. Illustrated detailed description of chassis, engine, etc. 800 w. Autocar—Feb. 10, 1912. No. 30656 A.

Car Lighting

Electric Lighting for Automobiles. Illustrates and describes various systems. 8000 w. Automobile—Jan. 25, 1912. (Special.) No. 30075 C.

Dynamos for Motor Road Vehicle Lighting. J. D. Morgan. Abstract of paper before the Birmingham Soc. of Inst. of Elec. Engrs. Describes the various dynamo arrangements suggested. Diagrams. 2500 w. Elect'n, Lond—Jan. 19, 1912. No. 30154 A.

Commercial Vehicles

Increasing the Utility of Commercial Cars by Auxiliary Loading and Unloading Devices. Edward W. Curtis, Jr. Read before the Soc. of Auto. Engrs. Considers briefly the various devices in use. 2500 w. Horseless Age—Feb. 21, 1912. No. 30716.

Taking Care of the Freight Automobile. Illustrated article explaining how trucks are maintained to get the best service. 3500 w. Automobile—Feb. 15, 1912. No. 30451.

Construction

The Gasoline Automobile—Its Design and Construction. P. M. Heldt. The present article discusses the general structure of the car. 4000 w. Horseless Age—Feb. 21, 1912. Serial. 1st part. No. 30715.

New Automobile Construction (Neuere Automobil-Konstruktionen). E. Aders. Plates and description of the "Sperber" 1911 car. 2000 w. Motorwagen—Jan. 10, 1912. No. 30533 D.

Equipments

Some Special Applications of Gasolene-Electric and Storage Battery Automobile Equipments. H. S. Baldwin. Reviews recent applications of electric generators and motors to the propulsion of special conveyances. Ills. 4500 w. Gen Elec Rev—March, 1912. No. 30762 C.

Ignition

Construction of the High-Tension Coil. Explains how it is made and the theory of its action. Ills. 2000 w. Automobile—Feb. 1, 1912. No. 30230.

What the Big Shows Have Brought Out in the Ignition Field for 1912. Brief illustrated descriptions of new features in evidence. 5000 w. Automobile—Jan. 25, 1912. (Special.) No. 30074 C.

Industry

Impressions of the American Motor Industry. W. M. Letts. An account of an Englishman's visit to the New York show and to Detroit factories. 3000 w. Auto Jour—Feb. 17, 1912. No. 30785 A.

Japan

Jidosha—The Automobile in Japan. A. W. Babbitt. An illustrated account of recent progress in the automobile indus-

try in Japan. 4500 w. Horseless Age—Feb. 14, 1912. No. 30432.

Lubrication

Principles of Lubricating System Design. Illustrated review of methods employed. 6500 w. Automobile—Feb. 8, 1912. No. 30369.

Motor Cars

Betwixt and Between. W. G. Aston. Illustrates and describes types between the autocar and motor cycle, discussing the advantages and disadvantages of the several systems. 5000 w. Autocar—Jan. 20, 1912. No. 30151 A.

Gasolene Motor Cars. Illustrated description of cars used on the Nevada Copper Belt Ry. 700 w. Ry Gaz, Lond—Jan. 26, 1912. No. 30312 A.

Motor Vehicles

Petrol Rail Motor Coaches. T. F. Charlton and H. Grinstead. Read before the Coventry Branch of the Graduates Sec. of the Inst. of Auto. Engrs. Discusses the design of these vehicles, and the methods of transmission. 5000 w. Mech Engr—Jan. 19, 1912. No. 30165 A.

The Rural Motor Vehicle. Ernest Lincoln Ferguson. Considers the use of gasoline vehicles on the farm and the benefits derived. 2000 w. Sci Am—Feb. 10, 1912. No. 30331.

New Cars

The Briggs-Detroit—A New Car. Illustrates and describes a car soon to be placed on the market. 1500 w. Horseless Age—Feb. 21, 1912. No. 30717.

Poss

Poss Light Delivery Wagon. Brief illustrated description of features of a 1000 pound motor delivery wagon. 1000 w. Horseless Age—Feb. 7, 1912. No. 30374.

Progress

Digest of 1911 Chemical Progress Affecting Automobile Construction. Discusses the making of artificial rubber and other inventions relating to colorings for metals. 4500 w. Automobile—Feb. 22, 1912. Serial. 1st part. No. 30769.

Repairs

The Repair of Motor Vehicles. David J. Smith. Read before the Inst. of Auto. Engrs. Deals especially with difficulties which do not arise in manufacture. 3000 w. Horseless Age—Feb. 7, 1912. No. 30373.

Self-Starters

A New Self-Starting Device. Illustrated description of a device utilizing the magneto armature instead of a separate high-tension coil. 1500 w. Autocar—Feb. 10, 1912. No. 30657 A.

Sheffield-Simplex

The 25 H.P. Sheffield-Simplex Car. Illustrated description. 1500 w. Auto Jour—Feb. 3, 1912. Serial. 1st part. No. 30388 A.

Shops

Operations on Dorris Motor Car Parts. F. A. Stanley. Illustrates and describes

tables and methods used. 1200 w. Am Mach—Feb. 15, 1912. No. 30419.

Springs

Pneumatic "Springs" for Automobiles. Illustrated description of the Westinghouse air spring as applied to an automobile. 1600 w. Eng News—Feb. 15, 1912. No. 30438.

Suspension

Auxiliary Suspension. A review of the principal modern devices showing the advantages of supplementary springs. Ills. 4000 w. Autocar—Feb. 3, 1912. No. 30389 A.

Torque-Stays

Torque-Stays and Radius-Rods. Explains their importance in transmitting the engine-power to the road-wheels of a car, and some of the difficult problems designers must solve. Ills. 1500 w. Auto Jour—Jan. 20, 1912. Serial. 1st part. No. 30150 A.

Tractors

Improved Steam Tractor. Illustrated detailed description of a steam tractor with condenser and spring draught gear. 1200 w. Engr, Lond—Feb. 2, 1912. No. 30410 A.

Making the "Tractioneer." Lynn W. Ellis. Illustrated article on schools where traction engineering and farming are taught. 2500 w. Sci Am—Feb. 10, 1912. No. 30330.

Transmission Noises

Contributory Causes of Transmission Noise. E. J. Bartlett. An analysis of the causes of noise in the transmission and suggestions for its reduction or elimination. Ills. 3000 w. Horseless Age—Jan. 24, 1912. (Special.) No. 30096 C.

Trucks

Some Notes on the Development of Motor Trucks for Contractors' Service, With Data Concerning Operating Cost. Illustrates and describes several types of trucks adapted more or less particularly to contractors' and builders' hauling. 3500 w. Engng & Con—Feb. 7, 1912. No. 30376.

Worm-and-Gear Final Drive for Trucks. Ralph H. Rosenberg. Read before the Soc. of Auto. Engrs. Explains the developing of a design, and considers the cost and durability of the system. 1200 w. Automobile—Feb. 1, 1912. No. 30231.

The Trend in Truck Transmissions, Also Modern Clutch Construction, as Seen at the Shows. D. R. Hobart. Ills. 2500 w. Com Veh—Feb., 1912. No. 30261 C.

Utilizing the Total Overall Length of the Truck. Illustrates and describes some recent designs. 2200 w. Automobile—Feb. 8, 1912. No. 30368.

See also Motor Vehicles under *Automobiles*.

Universal Joint

The Universal Joint (Die Beweglichkeit der Knochengelenke). O. Winkler. Describes the construction and sphere of

activity of the universal joint. Ills. Serial. 1st part. 1800 w. Motorwagen—Jan. 31, 1912. No. 30545 D.

Valveless

Valveless Four Stroke Motors (Les Moteurs sans Soupapes a quatre temps). G. Laverigne. The Knight and other types of valveless motors are discussed. Ills. 3600 w. Rev Gen des Sciences—Jan. 15, 1912. No. 30603 D.

New Motors for Automobiles (I nuovi motori per vetture automobile). C. Boella. Comparison of the Knight silent motor and the Itala valveless motor. Ills. 2400 w. Industria—Jan. 7, 1912. No. 30636 D.

Valves

Valves—Tendencies and Design. Illustrates and describes types. 5500 w. Automobile—Jan. 25, 1912. (Special.) No. 30076 C.

Valve Sleeves

See Shop Practice, under MECHANICAL ENGINEERING, *Machine Works and Foundations*.

COMBUSTION MOTORS

Gas Engine Economy

Comparison of Commercial Economy of Gas Engines and Steam Turbines. Franklin M. Farwell. Gives practical data relating to operation of blast-furnace gas-engines with electrical generators. 2500 w. Elec Wld—Feb. 3, 1912. No. 30265.

Gas Engines

Points in the Design of Two-Stroke Cycle Engines. S. M. Howell. Considers the principles of satisfactory design, examples, and changes required for oil engines. Ills. 2500 w. Mach, N Y—Feb., 1912. No. 30125 C.

The Gas Turbine. J. Lange. Trans. from article in *Stahl und Eisen*. Illustrates discussion of types and designs, with remarks on their operation. 2500 w. Power—Feb. 13, 1912. No. 30386.

The Holzwarth Gas Turbine. Illustrates and describes a new type of gas turbine, giving results of investigations. 4000 w. Power—Feb. 6, 1912. No. 30271.

Oil Engines

See Diesel Engines and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Rating

The Rating of Petrol Engines. Editorial discussing the rating from the point of view of the taxation authorities. 2500 w. Engng—Feb. 2, 1912. No. 30404 A.

Suction Gas

A Few Problems in Bituminous Suction-Gas Plants. Frank Fielden. Discusses the possibility of using cheaper fuel, the need of an intimate mixture of air at a suitable temperature, mechanical feeding, etc. 3500 w. Engng—Feb. 9, 1912. No. 30668 A.

HEATING AND COOLING

Cold Storage

Cold Storage of Furs and Fabrics. E. F. Tweedy. Explains the methods in use,

and describes plants and operation. 3000 w. Power—Feb. 20, 1912. No. 30485.

Dust-Elimination

Dust in Portland Cement Plants. Otto Schott. Describes dust-eliminating devices and methods. 5000 w. Cement & Engng News—Feb., 1912. No. 30820.

Factories

Home Office Regulations of Humidity in Weaving Sheds. Reprint of regulations under the Factory and Workshops Act, to come into force April 1, 1912. 2000 w. Mech Engr—Jan. 19, 1912. No. 30164 A.

Air Heating and Humidifying in Textile Mills (Il calore e l'inumidimento degli ambienti nella lavorazione delle fibre tessili). H. Neu. Discusses the necessary temperature and humidity in textile mills and presents methods for obtaining them. Serial. 1st part. 2100 w. Industria—Jan. 7, 1912. No. 30637 D.

Heat Problems

Heat Problems. Editorial review of a paper by Sir James Dewar, before the Roy. Inst., giving an account of recent investigations at low temperatures. 1500 w. Engng—Jan. 26, 1912. No. 30319 A.

Hot Water Heating

Auxiliaries for Pressure Systems of Hot Water Heating. J. J. Wilson. Read before the Am. Soc. of Heat. & Vent. Engrs. Drawings and descriptions of methods used to install some of these specialties. 1200 w. Heat & Vent Mag—Feb., 1912. No. 30447.

Vacuo Hot Water Heating by Forced Circulation. Ira N. Evans. Gives the principal points of the general discussion of the subject of forced hot water heating. 2800 w. Heat & Vent Mag—Feb., 1912. No. 30446.

Ice-Making

The Exhaust-Steam Ice-Making Plant in Hempel & Co.'s Municipal Brewery in Stadthagen (Die Abdampf-Eismaschinen-Anlage in der Städtischen Brauerei Hempel & Co. in Stadthagen). Georg Götsche. Description of plant. Ills. 2700 w. Kälte-Industrie—Jan., 1912. No. 30589 D.

See also Central Stations, under ELECTRICAL ENGINEERING, *Generating Stations*.

Piping

Heating a Twelve-Story Loft Building. Illustrates and describes details of piping and provisions to care for expansion and contraction. 2200 w. Met Work—Feb. 16, 1912. No. 30449.

Refrigeration

Marine Refrigeration. John Creen. Considers refrigerating problems on ship-board, refrigerants used, typical marine installations, etc. 2500 w. Ice & Refrig—Feb., 1912. No. 30259 C.

The Science and Industry of Refrigeration (La scienza e l'industria del freddo). G. Q. Ruata. Treating of the theory of refrigeration and the operation of refrig-

erating plants. Serial. 1st part. 2400 w. Industria—Feb. 4, 1912. No. 30639 D.

Schools

The Heating and Ventilation of Schools. Charles L. Hubbard. The present article deals with buildings of eight rooms and less, employing furnaces or indirect steam heat. 3000 w. Br Build—Jan., 1912. Serial. 1st part. No. 30196 D.

Steam Heating

Steam Heating Large Department Stores. Davis S. Boyden. Read before the Am. Soc. of Heat. & Vent. Engrs. Particulars in regard to a heating plant in a Boston store. 2000 w. Power—Feb. 27, 1912. No. 30784.

Vacuum

The Production of Vacuum and Some of Its Applications (Etude sur la Production du Vide et Certaines de ses Applications). M. Leblanc. Especially dealing with refrigeration. Ills. and plate. 14700 w. Mem Soc Ing Civ de France—Nov., 1911. No. 30593 D.

Ventilation

The Influence of Ozone in Ventilation. Leonard Hill and Martin Flack. Discusses the supposed existence of organic chemical poisons in air, showing them to be usually harmless, and their effect due to smell. Reports experiments and considers the general principles of heating and ventilating. Discussion. 6500 w. Jour Soc of Arts—Feb. 9, 1912. No. 30476 A.

Modern Ventilation, Dust Removal and Hot Air Heating in Foundries (Neuzeitliche Lüftungs-Entstaubungs- und Lüftheizungs-Anlagen in Giessereibetrieben). E. Danneberg. Describes fans and other devices for foundry work. Ills. 8000 w. Giesserei Zeitung—Jan. 1, 1912. No. 30571 D.

Water Coolers

Modern Water Coolers for Factories. Illustrates and describes types of re-cooling plants used in Germany. 1500 w. Sci Am Sup—Feb. 3, 1912. No. 30208.

HYDRAULIC MACHINERY

Air Lift

Properties of the Air Lift Pump—Its Advantages and Disadvantages. G. J. Davis and C. R. Weidner. Abstract of *Bul.* 450, *Univ. of Wis.* Illustrates and describes its structural features, an air lift pumping plant, and discusses its usefulness. 4500 w. Engng & Con—Feb. 14, 1912. No. 30425.

Automatic Pumps

Automatic Water Supply Booster. C. A. Tupper. Illustrates and describes an interesting auxiliary plant in Germany. 1200 w. Eng News—Feb. 8, 1912. No. 30358.

Hydrodynamics

The Conversion of Kinetic to Pressure Energy in the Flow of Water Through Passages Having Divergent Boundaries. A. H. Gibson. Deals with results of experimental work in so far as it is likely

to affect hydraulic design. 1800 w. Engng—Feb. 16, 1912. No. 30795 A.

Experiments to Determine the Pressure and Centre of Pressure on Perpendicular Plates when Towed Directly or Obliquely through Water (Untersuchungen über den Druck und Druckmittelpunkt an lotrechten Platten, die recht- und spitzwinklig zur Fahrtrichtung durch Wasser geschleppt werden). Franz Matthias. With special reference to pressure on the rudders of air and water craft. Ills. Serial. 1st part. 5600 w. Schiffbau—Jan. 10, 1912. No. 30585 D.

Hydraulic Pressure Regulation (Hydraulische Druckregulatoren). R. Dubs and A. Utard. Presenting the theory of such regulation and describing various regulators. Serial. 1st part. 3500 w. Schweiz Bau—Jan. 6, 1912. No. 30541 D.

Pumps

Rebuilding Three Large Pumping Engines. Charles B. Buerger. A description of reconstruction work for the Philadelphia Bureau of Water. Ills. 5000 w. Pro Am Soc of Civ Engrs—Feb., 1912. No. 30902 F.

See also Air Lift under *Hydraulic Machinery*.

Turbine Governing

Application and Explanation of Brake Tests on Water Turbines from Camerer's Diagram (Beitrag zur Nachrechnung und Auslegung von Bremsversuchen an Wasserturbinen nach dem Diagramm von Prof. Dr. Camerer). Otto Böhm. Results of tests of varying nature to determine correctness of the diagram. Ills. Serial. 1st part. 2800 w. Zeit f d Ges Turbinenwesen—Jan. 10, 1912. No. 30580 D.

Devices for the Proper Control of Turbine Velocity under Various Conditions (Untersuchung über das allgemeine Verhalten des Geschwindigkeitskoeffizienten von Leitvorrichtungen des praktischen Dampfturbinenbaues bei verschiedenen Betriebsbedingungen). P. Christlein. Notes and experiments. Ills. Serial. 1st part. 3000 w. Zeit f d Ges Turbinenwesen—Jan. 10, 1912. No. 30579 D.

New Turbine Regulators Made by Briegler, Hansen & Co., Gotha (Die neuen Turbinenregler von Briegler, Hansen & Co. in Gotha). Herr Thoma. Describes principles and construction of regulators. Ills. Serial. 1st part. 6000 w. Zeitschr des Ver deutscher Ing—Jan. 27, 1912. No. 30569 D.

Turbine-Pumps

The Evolution and Present Development of the Turbine-Pump. Edward Hopkinson and Alan E. L. Charlton. Considers the development of the Osborne-Reynolds pump, believed to be the original type. Ills. 4500 w. Inst of Mech Engrs—Jan. 19, 1912. No. 30317 N.

Turbines

The Föttinger Hydrodynamic Machine (Das hydrodynamische Getriebe von Föt-

tinger). H. Hoff. A new type of turbine and report on its power development. Ills. and plate. 4200 w. Stahl u Eisen—Jan. 11, 1912. No. 30503 D.

Valves

High Pressure Fire Gate Valves. George J. Henry, Jr. Illustrates and describes the new high-pressure gate-valves used in the system to protect San Francisco from fire, and the way in which they were made. Ills. 700 w. Am Mach—Feb. 22, 1912. No. 30689.

Catskill Aqueduct Control Valves. James Owen. Illustrates and describes the construction and operation of the 48-in. needle-valves, with the specifications for the valve materials. 3000 w. Eng News—Feb. 1, 1912. No. 30233.

See also Patterns, under *Machine Elements and Design*.

MACHINE ELEMENTS AND DESIGN

Air Compressor Design

See Air Compressors, under *Power and Transmission*.

Ball-Bearings

Causes of Failure in Ball-Bearings. G. F. Barrett. Abstract of paper read before the Inst. of Auto. Engrs. Considers troubles due to faulty design, material, workmanship, mounting, and bad usage. Ills. Serial. 4500 w. Auto Jour—Feb. 10, 1912. No. 30655 A.

Gears

Notes on the Theory of Gears (Notes sur la Théorie des Engrenages). A. R. Garnier. Mathematical discussion on gear design. Ills. 12000 w. Rev de Mecan—Dec. 31, 1912. No. 30601 E + F.

Lever

The Design of Levers. E. N. Weaver. Gives methods of calculating the gross sections necessary for control lever, with charts for finding dimensions of sections quickly. 2200 w. Horseless Age—Jan. 31, 1912. (Special.) No. 30243 C.

Machine Tools

Rational Machine Tool Design. J. T. Nicolson. Preface to a series of articles aiming to show that careful study of design from the theoretical side can be of assistance to the designer, and may improve the commercial efficiency. 1500 w. Prac Engr—Feb. 16, 1912. Serial. 1st part. No. 30792 A.

Patterns

Gate-Valve Spindle and Hand-Wheel Patterns. F. W. Barrows. Discusses materials, construction, design, etc. Ills. 4500 w. Castings—Feb., 1912. No. 30635.

Splitting Patterns. Walter J. May. Suggestions from a moulder's point of view. Ills. 700 w. Prac Engr—Feb. 2, 1912. No. 30396 A.

Contraction, and the Making of a Pattern for a Preso Table. W. Potter. Illustrated description of method adopted. 1000 w. Mech Wld—Jan. 26, 1912. No. 30309 A.

Propeller Design

Laying Out Propellers. Olaf Malvig. Explains a method which the author has found very satisfactory. Ills. 1000 w. Mach, N Y—Feb., 1912. No. 30123 C.

Shafts

Graphical Methods in the Design of Shafts. A. Schein. This first of two papers considers shaft design for two-bearing machines. 2500 w. Gen Elec Rev—March, 1912. Serial. 1st part. No. 30767 C.

Springs

Some Notes on Springs, Principally with Reference to Those for Railway Rolling-Stock. George W. Shearer. A report of investigations and results on springs. Ills. 3000 w. Engng—Feb. 16, 1912. No. 30796 A.

Templets

Templets for Marine Engines. On the making and use of templets. Drawings. 2500 w. Mech Wld—Feb. 2, 1912. No. 30398 A.

Tool Design

See Tools, under *Machine Works and Foundries*.

Valves

See Brake Valves, under *RAILWAY ENGINEERING, Motive Power and Equipment*.

MACHINE WORKS AND FOUNDRIES

Accident Prevention

Methods of Safeguarding Machine Tools. Illustrations and notes on the prevention of accidents, and the equipment of tools to protect the workmen. 1000 w. Ir Trd Rev—Feb. 22, 1912. No. 30706.

Automatic Tools

A Semi-Automatic Profiler. Illustrated description of a new automatic profiler for the economical production of gun and pistol parts, cams, etc. 1500 w. Am Mach—Feb. 15, 1912. No. 30420.

Boring Machine

Automatic Tire Boring Machine. Illustrated description of a machine used for this work in the German Niles Machine Tool Works. 1200 w. Engr, Lond—Feb. 16, 1912. No. 30804 A.

The Wigglesworth Boring Mill. Illustrates and describes novel constructional details. 1500 w. Ir Age—Feb. 29, 1912. No. 30857 C.

Bronze Castings

The Production of Artistic Bronze Castings. C. Vickers. Discussion of methods of molding and alloys best adapted for the work. Ills. 3500 w. Foundry—Feb., 1912. No. 30133.

Burnishing

Machine for Burnishing Metal Bars and Tubes, Bliss System (Machine à rétrécir les tiges et tubes métalliques, système Bliss). M. Lunet. Description of recent invention of burnishing lathe. Ills. 2400 w. Génie Civil—Jan. 27, 1912. No. 30622 D.

Casehardening

New Casehardening Methods. E. F. Lake. Reviews the old methods and describes the new. Ills. 4000 w. Mach, N Y—Feb., 1912. No. 30126 C.

Selective Hardening and Carbonizing. A fire-paint which is impervious to the action of carbon. Ills. 1200 w. Am Mach—Feb. 8, 1912. No. 30279.

The Theory and Practice of Cementation (Ueber den gegenwärtigen Stand von Theorie und Praxis des Zementationsprozesses). L. Guillet. A summary of the principles employed. Translated from *Le Génie Civil*. Serial. 1st part. 2500 w. Stahl u Eisen—Jan. 11, 1912. No. 30506 D.

Castings

Pellets and Segregation in Iron Castings. E. L. Rhead. Read before the Manchester Sec. of the British Found. Assn. Discusses their effect on the properties of the metal. 2500 w. Mech Engr—Feb. 16, 1912. No. 30794 A.

Peculiarities of Aluminum Castings. J. B. Thurman. From *So. Mach.* Information concerning the alloys used, the proper handling and care. 1500 w. Mech Engr—Jan. 26, 1912. No. 30305 A.

The Manufacture of Malleable Iron Stove Plate. Illustrates and describes methods used in a Wisconsin foundry. 2500 w. Ir Trd Rev—Feb. 8, 1912. No. 30332.

Manufacture of Malleable Iron Stove Plate. Illustrated description of methods pursued in a Wis. foundry. 2000 w. Foundry—Feb., 1912. No. 30136.

Perpendicular Streaks in Castings (Seigerungserscheinungen in Gussstücken). B. Osann. Additional remarks to the paper by T. D. West on "Gas Cavities, Shot and Chilled Iron, in Iron Castings." Serial. 1st part. Ills. 2000 w. Stahl u Eisen—Jan. 25, 1912. No. 30511 D.

Chip Briquettes

The Recovery of Metal Chip Briquettes at the Plant of the High Pressure Briquetting Co., Ltd., Berlin (Brikettieranlagen zur Herstellung von Eisen- und Metallspäne-Briketts der Hochdruckbrikettierung G. m. b. H. in Berlin). J. Mehrtens. Illustrated description of plant and process. 3500 w. Stahl u Eisen—Jan. 25, 1912. No. 30510 D.

Cores

Core Department of the Missouri Malleable Company. Illustrates and describes truck ovens and various cars used, the fuel and firing, conveyance and inspection of cores, etc. 900 w. Castings—Feb., 1912. No. 30684.

Cupola Practice

Pertinent Suggestions for Cupola Operators. P. Munnoch. Read before the Am. Found. Assn. Discussion of furnace charging, fuel ratios, fluxing, the action of slags, and the melting of steel. 3000 w. Foundry—Feb., 1912. No. 30137.

Cutter Sharpening

Sharpening Milling Cutters. F. B. Jacobs. Directions for sharpening and care of cutters. Ills. 3000 w. Mach, N Y—Feb., 1912. No. 30124 C.

Cutting Tools

Sapphire Tools for Cutting Metal. Herbert L. Thompson. Explains how such tools should be ground and used. Ills. 2500 w. Am Mach—Feb. 1, 1912. No. 30118.

Dies

Cold Swaging Dies for Steel Parts. D. H. Chason. Describes methods employed and results obtained in accurate work requiring maximum durability at low cost. Ills. 2500 w. Am Mach—Feb. 22, 1912. No. 30686.

Dies for Patent Fasteners. Wilhelm Müller. Illustrated description of German follow-up dies for forming small brass parts complete at each stroke of the press. 600 w. Am Mach—Feb. 29, 1912. No. 30872.

Drilling Machines

Modern Radial Drilling Machines. Illustrates and describes a number of machines by various makers. 4500 w. Mech Wld—Jan. 19, 1912. (Supplement.) No. 30168 A.

Dust Extraction

Mechanical Appliances for Dust Extraction in Cotton Mills. H. M. Crawford. Illustrates and describes applications of the vacuum principle. 2500 w. Cassier's Mag—Feb., 1912. No. 30284 B.

Foundries

The Iron Foundry in the Last Ten Years (Das Eisengiessereiwesen in den letzten zehn Jahren). E. Leber. Review of developments and practice throughout the period. Serial. 1st part. 4500 w. Stahl u Eisen—Jan. 25, 1911. No. 30509 D.

Hanging Rooms, Drains, Molding and Casting Pits Required in Plants for Medium and Heavy Castings (Trockenkammer, Trockengruben, Form- und Giessgruben nebst dazugehörigen Betriebsmitteln für mittleren und schweren Guss). E. Skamel. Discusses the arrangements for the necessary conveniences of this sort in foundries. Serial. 1st part. 1400 w. Giesserei-Zeitung—Jan. 1, 1912. No. 30574 D.

See also Ventilation, under *Heating and Cooling*.

Foundry Management

See Management, under **INDUSTRIAL ECONOMY**.

Foundry Practice

British Brass Foundry Practice Discussed. Brief discussion of types of furnaces used. 1500 w. Foundry—Feb., 1912. No. 30138.

Making Cast-Iron Pulleys. Describes method used for making arm pulleys by hand. Ills. 1000 w. Mech Wld—Jan. 19, 1912. No. 30167 A.

An Uninterrupted Foundry Plant (Ein ununterbrechener Eisengiessereibetrieb). Describes a circular continuously operated plant. Ills. Serial. 1st part. 2100 w. Giesserei-Zeitung—Jan. 1, 1912. No. 30573 D.

Economics and Improvements in Metal Foundries (Ueber Betriebsersparnisse und Verbesserungen in der Metallgiesserei). Treating on the management of the plant. Serial. 1st part. 1600 w. Giesserei-Zeitung—Jan. 1, 1912. No. 30572 D.

Testing Raw Materials and Bi-Products in Foundries (Ueber die Probenahme von Rohstoffen und Zwischenerzeugnissen auf den Hüttenwerken). W. Schäfer and E. Corleis. Papers presented before the German Founders Association. 3500 w. Stahl u. Eisen—Jan. 11, 1912. No. 30505 D.

Furnaces

Firebrick Furnace Arches. A. E. Dixon. Suggestions as to proper mortar to use, how to lay the brick, etc. 1200 w. Power—Feb. 20, 1912. No. 30483.

Russian Wood-burning Furnaces. Illustrates and describes types. 1500 w. Prac Engr—Feb. 9, 1912. No. 30663 A.

McLean's Compensated Draught Furnaces. Drawings showing how the draught compensation is effected. 2000 w. Engng—Feb. 9, 1912. No. 30670 A.

Galvanizing

Mechanical Electro-Galvanizing. Address before the Nat. Electro-Platers' Assn. Describes the cold process of coating metal with zinc and the different machines used. Ills. 2000 w. Ir Age—Feb. 15, 1912. No. 30417.

Galvanizing Iron and Steel (Le Zingage du Fer et de l'Acier). M. Sang. Presenting the modes of treatment in the heat process, electrolytic process, sherardizing and other processes. 15000 w. Rev de Métallurgie—Jan., 1912. No. 30602 H.

Gears

Holding Gears for Grinding. Gives several methods of chucking hardened gears. Ills. 1500 w. Am Mach—Feb. 8, 1912. No. 30276.

See also same heading under *Machine Elements and Design*.

Grinders

Horn Comb Finishing Machines. Illustrates and describes grinders of various kinds for this work. 1500 w. Am Mach—Feb. 1, 1912. No. 30119.

New Model Vertical Surface Grinder. Illustrated description of a grinder which will handle either plain or circular grinding. 1000 w. Am Mach—Feb. 8, 1912. No. 30277.

See also Gears, under *Machine Works and Foundries*.

Jigs

Jigs of the Saurer Motor Factory. Ethan Viell. Illustrates and describes a number of jigs, showing shop practice. 900 w. Am Mach—Feb. 22, 1912. No. 30687.

Knurling

Knurling in the Screw Machine. S. Nevin Bacon. Describes methods of knurling as applied in different factories. Ills. 700 w. Am Mach—Feb. 8, 1912. No. 30280.

Knurling Tools for Screw Machines. S. Nevin Bacon. Illustrated descriptions of special tools. 1000 w. Am Mach—Feb. 22, 1912. No. 30690.

Lathes

The Bench Lathe and Its Uses. Edward K. Hammond. Illustrated description of these machines and operations performed on them. 4000 w. Mach, N Y—Feb., 1912. No. 30122 C.

Looms

A Rotary Circular Loom. Illustrated detailed description of an ingenious machine for weaving fabrics into tube form. 1000 w. Engr, Lond—Feb. 2, 1912. No. 30411 A.

Machine Tools

What Constitutes a Machine Tool? A synopsis of decisions by the U. S. General Appraisers and the U. S. Court of Customs Appeals. 2500 w. Ir Age—Feb. 29, 1912. No. 30856 C.

High-Speed Steel Tools on Low and Medium Power Machines (Les Outils en Acier rapide sur les Machines de faible et de moyenne puissance). P. Gorgen. Presents arguments on the economic results to be obtained by their use. Ills. 8600 w. Technique Moderne—Feb. 1, 1912. No. 30610 D.

Metal Coloring

Anodal Metal Coloring in Ammonia Baths (Untersuchungen über anodische metallfärbung in ammoniakalischen Bädern). V. Paissakowitsch. Description of the process. Serial. 1st part. 1500 w. Elektrochem Zeit—Jan., 1912. No. 30531 D.

Molding Machines

Present State of Molding Machine Operation in North America (Gegenwärtiger Stand des Formmaschinenwesens in Nordamerika). U. Lohse. Discusses American practice and machines used. Ills. Serial. 1st part. 4500 w. Zeitschr des Ver deutscher Ing—Jan. 20, 1912. No. 30568 D.

Planer Drives

Comparative Tests of Planer Drives. Samuel S. Roberts. Reports an investigation of the belt-driven and reversing-motor driven types. 1200 w. Am Mach—Feb. 1, 1912. No. 30116.

Reamer

Vickers' Adjustable Reamer. Illustrated description. 900 w. Engng—Feb. 16, 1912. No. 30797 A.

Rolls

Unpitched Broad-Flanged Channels (Neigungslose Breitflanschträger). P. Hundsdörfer. Description of rolls for rolling channels and other sections without end inclination. Ills. 2500 w. Glaser's Annalen—Feb. 1, 1912. No. 30548 D.

Screw Cutting

Cutting Multiple Thread Screws in the Lathe. W. H. Davies. Illustrated detailed description of methods used. 1500 w. Mech Wld—Jan. 19, 1912. No. 30166 A.

See also Knurling, under *Machine Works and Foundries*.

Shop Lighting

The Artificial Lighting of Machines. C. E. Clewell. Discusses important features of machine tool illumination and related topics. Ills. 3500 w. Am Mach—Jan. 25, 1912. No. 30111.

Shop Practice

Machining Venturi Meter Parts. Dana W. Pond. Illustrated account of methods used to finish parts of unusual size, intended for meters to be placed in the Catskill Aqueduct. 800 w. Am Mach—Feb. 15, 1912. No. 30421.

Methods and Tools in a Press Shop. F. A. Stanley. Illustrates and describes tools and practice in a St. Louis shop. 2000 w. Am Mach—Feb. 1, 1912. No. 30117.

Manufacturing an Adding Machine. F. A. Stanley. Illustrates and describes interesting methods and machines. 2000 w. Am Mach—Feb. 29, 1912. No. 30867.

Making Repair Parts for Locomotives. Illustrates and describes methods and fixtures used in a Kansas shop. 1500 w. Am Mach—Feb. 29, 1912. No. 30868.

Magazine Attachments. Douglas T. Hamilton. Describes magazine attachments applied to the Brown & Sharpe automatic screw machine. Ills. 3500 w. Mach, N Y—Feb., 1912. Serial. 1st part. No. 30128 C.

Points in the Machining of Tapers. George W. Burley. Considers the position of the lathe tool in relation to the work. Ills. 1500 w. Mech Wld—Jan. 26, 1912. No. 30306 A.

Automatic Lathe Work. Abstract of a paper by P. V. Vernon, read before the Coventry Engng. Soc. Discusses the question of costs in determining what methods to use, and related topics. 1800 w. Mech Wld—Jan. 19, 1912. No. 30170 A.

Gray Iron Foundry Operating Economies. H. Cole Estep. Explains how the use of labor-saving machinery reduced producing costs. 3500 w. Ir Trd Rev—Feb. 22, 1912. No. 30707.

Tools and Methods of a Vermont Shop. Ethan Viall. Illustrates and describes jigs and tools used in a shop building wood-working machinery. 1200 w. Am Mach—Feb. 8, 1912. No. 30274.

Making Knight Motor Valve Sleeves. Ethan Viall. Illustrates and describes interesting shop practice in connection with the machining of cast-iron valve sleeves. 700 w. Am Mach—Feb. 1, 1912. No. 30115.

Making the Press-Button Knife. G. P. Campbell. Illustrates and describes tools and operations. 2200 w. Mach, N Y—Feb., 1912. No. 30127 C.

Shops

An Interesting Shop in the Tropics. Fred H. Colvin. Illustrates and describes work handled in a shop near Havana, Cuba. 1200 w. Am Mach—Feb. 29, 1912. No. 30871.

The Plant Behind Cincinnati Millers. L. P. Alford. Illustrated description of interesting details of construction and equipment of the new shop of the Cincinnati Milling Machine Co. 3000 w. Am Mach—Feb. 22, 1912. No. 30691.

Spindles

Recent Lathe Spindles (Neuere Drehbank-Spindelstöcke). A. Johnen. Discusses modern spindle arrangements. Ills. 1800 w. Zeitschr für Werkzeug—Jan. 15, 1912. No. 30578 D.

Steel Balls

The Manufacture of Steel Balls. Robert H. Grant. The first of a series of articles on steel-ball making, the machines and methods used, etc. Ills. 5000 w. Mach, N Y—Feb., 1912. Serial. 1st part. No. 30120 C.

Tools

Design of a Punch and Shear. N. Leerberg. Gives method, factors of design, and formulae used in designing a combination punch and shear. Ills. 2000 w. Am Mach—Feb. 29, 1912. No. 30870.

Moon Motor Car Jigs and Fixtures. Illustrates and describes special tools used in a St. Louis shop. 1000 w. Am Mach—Feb. 29, 1912. No. 30869.

Turrets

An Innovation in Turret Design. Illustrates and describes the method of design, construction, and tests of a new turret built by the Bullard Company. 2500 w. Am Mach—Feb. 1, 1912. No. 30114.

Vacuum Cleaners

The Vacuum Cleaner in the Shop. Ethan Viall. Illustrates and describes three installations for different purposes. 600 w. Am Mach—Jan. 25, 1912. No. 30112.

Wire Forming

Tools for Four-Slide Automatic Wire-Forming Machine. Chester L. Lucas. Illustrates and describes the important features and a few sets of wire-forming tools. 4000 w. Mach, N Y—Feb., 1912. No. 30121 C.

MATERIALS OF CONSTRUCTION**Alloys**

Micrographic Examination of Failures. J. S. Glen Primrose. Abstract of lecture before Glasgow Univ. Engng. Soc. Explains the methods adopted for investigating failures of engineering materials, especially the alloys of iron and steel. Ills. 2200 w. Can Engr—Feb. 8, 1912. No. 30372.

On the Behavior of Certain Alloys When Heated in Vacuo. Thomas Turner. Read before the Inst. of Metals. A report of experimental investigation of a num-

ber of alloys. 2500 w. Mech Engr—Jan. 26, 1912. No. 30302 A.

A Study of the Properties of Alloys at High Temperatures. G. D. Bengough. Read before the Inst. of Metals. Introductory explanation, with an account of research work, discussing only the properties of maximum stress, elongation, and contraction of area under static tension. Ills. 6000 w. Engng—Jan. 19, 1912. Serial. 1st part. No. 30177 A.

Copper and Its Alloys in Early Times. William Gowland. Pres. address (slightly abridged) to the Inst. of Metals, Jan. 16, 1912. Reviews the early history and methods followed by prehistoric man for the manufacture of weapons and instruments. Ills. 2500 w. Engr, Lond—Jan. 19, 1912. Serial. 1st part. No. 30183 A.

The Influence of Oxygen on Copper Containing Arsenic or Antimony. R. H. Greaves. Abstract of paper read before the Inst. of Metals. Describes research work and results. Ills. 3000 w. Mech Engr—Feb. 9, 1912. No. 30666 A.

The Influence of Remelting and Cooling upon the Chemical and Mechanical Properties of Alloys (Einfluss der Umschmelzung und Abkühlung auf die chemischen und mechanischen eigenschaften von Lagermetallen). G. Goldberg. Discussion. Serial. 1st part. 1700 w. Giesserei-Zeitung—Jan. 15, 1912. No. 30575 D.

Alloy Steels

Recognizing Alloy Steels by Ingot Structure. E. T. Edwards. Discusses visual and laboratory selections of steels, requirements of tool and other steels and the alloys to meet them. Ills. 2000 w. Ir Age—Feb. 15, 1912. No. 30415.

Aluminum

See Castings, under Machine Works and Foundries.

Brass

The Influence of Tin and Lead on the Microstructure of Brass. F. Johnson. Read before the Inst. of Metals. Describes a series of experiments made to determine the exact relations between tin and lead when occurring together in brass. Ills. 1500 w. Mech Engr—Feb. 9, 1912. No. 30665 A.

Standard Brass Foundry Mixtures and Method of Making Them. Erwin S. Sperry. Information concerning the non-ferrous metal mixtures used in the brass foundry. Ills. 4000 w. Brass Wld—Feb., 1912. Serial. 1st part. No. 30472.

Cast Iron

Cast Iron in Theory and Practice. E. Adamson. Deals with the theories for working to analysis. General discussion of methods. Ills. 16500 w. Jour W of Scotland Ir & St Inst—Nov., 1911. No. 30899 N.

Pig-Iron

Nickel Pig-Iron (Nickel-Roheisen). H. Thaler. Chemical and micrographical

studies of this material. Serial. 1st part. 1800 w. Giesserei-Zeitung—Feb. 1, 1912. No. 30576 D.

Tool Steel

Structure and Heat Treatment of Tool Steel. J. V. Emmons. Read before the Metal Trds. Supts. & Foremen's Club, Cleveland, O. Considers results and methods of annealing, the distribution of cementite, etc. Ills. 3000 w. Ir Age—Feb. 22, 1912. No. 30704 C.

Wire Rope

Wire Rope Splicing. F. L. Johnson. Illustrated directions. 500 w. Power—Jan. 30, 1912. No. 30109.

Zinc

An Investigation of the Strength of Rolled Zinc. Herbert F. Moore. Reports tests, at the Univ. of Illinois, describing methods and stating results and conclusions. Ills. 4500 w. Univ of Ill, Bul 52—Dec. 26, 1911. No. 30647 N.

MEASUREMENT

Bureau of Standards

The National Bureau of Standards. J. D. Mooney. An account of the work and explanation of how it may be of use in the manufacturing arts. Ills. 4000 w. Am Mach—Feb. 15, 1912. No. 30418.

Dynamometers

A Direct-Reading Torsional Dynamometer. Illustrates and describes a power meter possessing marked advantages. 1000 w. Sci Am Sup—Feb. 3, 1912. No. 30205.

Feed Water Meters

The Measurement of Hot Feed Water. Illustrates and describes types of feed-water measuring devices. 1000 w. Prac Engr—Feb. 9, 1912. Serial. 1st part. No. 30664 A.

Interferometer

A Displacement Interferometer Adapted for High Temperature Measurement, Adiabatic Transformations of a Gas, etc. C. Barus. Abridged from the report to the Carnegie Inst. of Wash. Illustrated description of the apparatus and its use. 3500 w. Am Jour of Sci—Feb., 1912. No. 30442 D.

Laboratories

The Bessemer Laboratory. Illustrated description of this memorial laboratory which forms a part of the Royal School of Mines. 1200 w. Engr, Lond—Feb. 2, 1912. No. 30409 A.

Metal Testing

Classification of Construction Metals in the Shops of the French Society of Mechanical Construction (Classification et Emploi des Metaux dans les Ateliers de la Société Française de Construction Mécanique). J. Netter. Steels, etc., classified according to their testing strengths. Ills. Serial. 1st part. 2400 w. Technique Moderne—Feb. 1, 1912. No. 30611 D.

Observations on Dynamic Tensile Stresses (Betrachtungen über dynamische

Zugbeanspruchung). Rudolph Plank. Experiments, observations and results on metals under tension. Ills. Serial. 1st part. 7800 w. Zeitschr des Ver deutscher Ing—Jan. 6, 1912. No. 30563 D.

Meters

Various Types of Steam Meters. G. F. Gebhardt. Illustrated description of steam meters in which the steam is throttled and the pressure drop utilized to indicate the flow. 2200 w. Power—Feb. 13, 1912. No. 30385.

Power Tests

See Rolling Mills, under MINING ENGINEERING, *Iron and Steel*.

Pyrometry

High-Temperature Work. Editorial review of discussions before the Faraday Society. 3000 w. Engng—Feb. 9, 1912. No. 30672 A.

See also Interferometers, under *Measurement*.

Steam Meters

Various Types of Steam Meters. G. F. Gebhardt. General classification of steam flow meters and illustrated description of the principal types. 3000 w. Power—Feb. 6, 1912. Serial. 1st part. No. 30268.

Test Bars

The Influence of the Relative Width and Thickness on the Extension of Test-Bars. W. Gordon and G. H. Gulliver. Abstract of a paper before the Roy. Soc. of Edinburgh. 500 w. Engng—Jan. 26, 1912. No. 30323 A.

Testing Machines

Modern Testing Machines. C. A. M. Smith. The present article deals with apparatus for tension, compression, and bending tests. Ills. 2500 w. Cassier's Mag—Feb. 1912. Serial. 1st part. No. 30287 B.

Time Recorders

The Periodograph Recording System. W. L. Miller. Illustrated description of a recorder and of a system for keeping record of time taken by workmen on various operations. 1500 w. Am Mach—Feb. 15, 1912. No. 30422.

Weights

On the Extensive Use of the Avoirdupois Pound in the Ancient British Period. Wilfrid Airy. Supplementary to an earlier paper. 1200 w. Inst of Civ Engrs—No. 3947. No. 30492 N.

POWER AND TRANSMISSION

Air Compressors

The Design of Air Compressors. The present article considers modern types of air compressors and their action. Ills. 2200 w. Mech Wld—Jan. 19, 1912. Serial. 1st part. No. 30169 A.

Air Compressor Efficiency. B. M. Woodhouse. Read before the Rugby Engng. Soc. A discussion of compressor design and efficiency, especially air-valve design, cooling the air during compression,

and volumetric efficiency. Ills. 4000 w. Mech Engr—Jan. 26, 1912. No. 30303 A.

Compressed Air

Compressed Air in the Operation of Machine Tools (Application de l'air comprimé au fonctionnement des machines-outils). M. Lunet. Presents several conditions most suitable for the use of compressed air. Ills. 1500 w. Rev Industrielle—Jan. 6, 1912. No. 30627 D.

Compressors

Centrifugal Compressors. Louis C. Loewenstein. The present number considers the principle and the factors influencing effective operation. Ills. 3500 w. Gen Elec Rev—March, 1912. Serial. 1st part. No. 30763 C.

See also Air Compressors and Turbo-Compressors, under *Power and Transmission*.

Electric Drive

Applications of Electric Motors. M. Shuttleworth. Read before the Newcastle Sec. of the I. E. E. Points out some of the main considerations to be borne in mind when applying motors to everyday use. Discussion. 8000 w. Elec Engr, Lond—Feb. 9, 1912. No. 30679 A.

The Electrical Driving of Rolling Mills. C. A. Ablett. Abstract of paper read before the Inst. of Elec. Engrs. Discusses the variations in power required and devices for regulating it, the Ilgner system, etc. Discussions. 5000 w. Elec Rev, Lond—Feb. 9, 1912. No. 30659 A.

Lubricants

Lubricants, Their Properties and Uses. Robert Jeffrey. From a paper read before the Prac. Refrig. Engrs. Assn. Considers various lubricants and their properties. 2000 w. Power—Feb. 6, 1912. No. 30270.

Pulleys

Graphical Solution of Cone Pulleys. F. A. Halsey. Gives chart for finding the ratio of the geometrical progression, with explanation. 1500 w. Am Mach—Feb. 8, 1912. No. 30275.

See also Foundry Practice, under *Machine Works and Foundries*.

Tidal Power

The Possibilities of Power from the Tides. J. Royden Peirce. Gives results of tests at Mamaroneck and a discussion of methods used elsewhere. 2000 w. Eng Rec—Jan. 27, 1912. No. 30070.

Turbo-Compressors

Commercial Applications of the Turbine Turbo-Compressor. Discussion of Richard H. Rice's paper. 12000 w. Jour Am Soc of Mech Engrs—Feb. 1912. No. 30694 D.

STEAM ENGINEERING

Boiler Corrosion

An Investigation of Electrolysis in Boilers. W. R. C. Corson. An account of an investigation of a case of abnormal

tube fitting, with a description of the remedy. 2500 w. Locomotive—Jan., 1912. No. 30496.

Boiler Explosions

Traction Engine Boiler Explosion at Crowley. A report of the Board of Trade inquiry at Winchester. Ills. 3500 w. Mech Engr—Feb. 2, 1912. No. 30397 A.

Boilers

Calculations for the Bracing of Flat Surfaces in Boilers. J. P. Morrison. Illustrates methods of bracing, describing practice and giving tables. 2500 w. Boiler Maker—Feb., 1912. No. 30342.

The Suckling Water-Tube Boiler. Illustrated description, with statement of advantages claimed. 1200 w. Engng—Feb. 2, 1912. No. 30403 A.

See also same heading, under MARINE AND NAVAL ENGINEERING.

Boiler Tests

Tests of Old Boilers. Alex. M. Gow. Gives records of tests to destruction under hydrostatic pressure, of three 30-year-old boilers. Ills. 2000 w. Eng News—Feb. 1, 1912. No. 30234.

Combustion

Surface Combustion. William A. Bone. Explains the underlying principles and the results achieved, some applications and experiments. Ills. 9000 w. Jour Fr Inst—Feb., 1912. No. 30701 D.

Condensers

Properties of Air and Steam Mixtures in Relation to Condensing Plant. Thomas B. Morley. Tabulated data and diagram with explanation of method of calculating the data used, and showing its application. 2000 w. Engng—Jan. 19, 1912. No. 30173 A.

Condenser Tubes

See Corrosion, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Draft

Relative Economy of Various Types of Draft Equipment. T. F. J. Maguire. This first of three articles discusses stock installations for natural draft, considering economy of installation and operation. 2500 w. Engineering Magazine—March, 1912. No. 30835 B.

Engines

Horizontal Compound Tandem Engine. An engine exhibited by Franco Tosi at the Turin Exhibition is described. Plate & Ills. 1000 w. Engng—Feb. 9, 1912. No. 30671 A.

Knocks and Pounds in Steam Engines. John S. Leese. Deals especially with noises difficult to locate and those difficult to diagnose. 1000 w. Mech Wld—Jan. 26, 1912. Serial. 1st part. No. 30307 A.

Tests of a Triple-Expansion Steam Engine (Versuche an einer Dreifachexpansions-Dampfmaschine). H. Hanszel. Stating the nature of the tests and results obtained therefrom. Serial. 1st part. 5500 w. Zeitschr des Ver deutscher Ing—Jan. 13, 1912. No. 30566 D.

Exhaust Steam

Exhaust Steam Conversion in Steam Power Plants (Einige Dampfkraftanlagen mit Abwärmeverwertung). Max Höttinger. Discussion on the utilization of exhaust steam. Ills. Serial. 1st part. 3300 w. Zeitschr des Ver deutscher Ing—Jan. 6, 1912. No. 30562 D.

Feed-Water Heating

Surface Combustion Steam Generator and Feed-Water Heater. Brief illustrated description of a design invented by Messrs. Bone, Wilson & McCourt. 1200 w. Mech Engr—Jan. 26, 1912. No. 30301 A.

Flue Gas Temperatures

Temperature Pendants. Gives a convenient means for determining flue gas temperatures. 1500 w. Sci Am Sup—Feb. 3, 1912. No. 30206.

Fuel Purchasing

The Systematic Purchase of Coal. F. R. Hutton and J. L. Pultz. Outlines the practice of the Department of Water Supply, Gas and Electricity, New York City. 2500 w. Power—Feb. 27, 1912. No. 30782.

Fuels

The Gasification of Fuel. Charles Edward Lucke. Considers typical forms of producer construction in this third article of a series, showing the relations of fuel bed and coal and blast supply. Ills. 6000 w. Engineering Magazine—March, 1912. No. 30831 B.

Fuels—A Discussion of Their Uses and Abuses. R. P. Bolton. Presidential address before the Am. Soc. of Heat. & Vent. Engrs. On the necessity of conserving the country's resources and the use of waste materials. 2000 w. Ir Trd Rev—Feb. 8, 1912. No. 30333.

Gage Glasses

Water Gage Glasses. Charles S. Blake. Notes concerning their attachment and use. 1200 w. Locomotive—Jan., 1912. No. 30495.

Heat Transmission

Heat Carriers for Heat Engines. Discusses methods of transforming heat into useful work. 2200 w. Prac Engr—Feb. 2, 1912. Serial. 1st part. No. 30395 A.

Joints

Testing Flange Joints (Versuche mit Flanschenverbindungen). R. Baumann. Describes experiments on joints for steam pipe and engine construction. Ills. 7800 w. Zeitschr des Ver deutscher Ing—Feb. 3, 1912. No. 30570 D.

Oil Fuel

Oil Burning with Different Settings. Gives results of a series of tests made to determine the relative economy of different furnaces and the effect of variation in the draft when burning oil. Ills. 2000 w. Power—Feb. 6, 1912. No. 30269.

Boilers Fired with Liquid Fuel. Giulio Fumanti. Abbreviated translation of a

paper read at Rome, Italy, on Nov. 12, 1911. Explains the advantages and disadvantages of liquid-fuel firing, reviews types of burners, and reports tests made for the Italian Navy. 2200 w. Engng—Feb. 2, 1912. No. 30406 A.

Oil Separators

The Massys Oil Separator (Déshuileur de vapeur Massys). Describes the mechanical arrangement of this device, and compares its efficiency with other types. Ills. 3000 w. Rev Industrielle—Jan. 13, 1912. No. 30628 D.

Plant Design

Steam Power Plants. O. S. Lyford, Jr., and R. W. Stovel. Illustrates and describes types, designed by one company, showing that conventional design is not practicable, the bearing of location on cost, etc. General discussion. 14000 w. Pro Engrs' Soc of W Penn—Jan., 1912. No. 30811 D.

Safety Valves

Results of Tests on the Discharge Capacity of Safety Valves. E. F. Miller. Describes tests giving results both in form of a plot and numerically. Also addendum by A. B. Carhart. Ills. 4500 w. Jour Am Soc of Mech Engrs—Feb., 1912. No. 30693 D.

Smoke Prevention

See Locomotive Smoke, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Steam Properties

Experiments on Boiling in the Generation of Steam (Recherches sur l'ébullition dans les générateurs de vapeur). M. Emandaud. Boiling in closed vessels to test theories on the circulation of water in steam generators. Ills. 3500 w. Génie Civil—Jan. 6, 1912. No. 30614 D.

Superheating

British Practice in Superheating. Victor White. The advantages of superheating are discussed, and types of superheaters used in England are described. Ills. 3000 w. Power—Jan. 30, 1912. No. 30108.

Turbine Economy

See Gas Engine Economy, under *Combustion Motors*.

Turbines

A New Development in Steam Turbines. Describes turbine invented by J. H. Van Deventer. A combination of helical gears converted into an impact and reaction steam turbine for general application. Ills. 500 w. Ir Age—Feb. 1, 1912. No. 30193 C.

Recent Developments in Steam Turbine Practice. K. Baumann. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated review of the development of the Parsons, Curtis, Rateau, and Zoelly types. 1800 w. Mech Engr—Jan. 19, 1912. Serial. 1st part. No. 30162 A.

Steam Turbines for Auxiliary Purposes on Board Ship. Ernest N. Janson. Considers the advantages and applications, types of turbines, etc. Ills. 5500 w. Int Marine Engng—Feb., 1912. No. 30212 C.

Ferranti's Steam Turbine. Illustrated description of a turbine in which the blade-carrying stator is enclosed within an outer casing and is free from the usual distortional stresses. 1500 w. Mech Engr—Jan. 26, 1912. No. 30300 A.

The Sturtevant Steam Turbine. Illustrated description of the latest model. 1500 w. Power—Feb. 20, 1912. No. 30484.

Valve Leakage

The Leakage of Steam Past Piston Valves. H. Denzil Lobley. Reports experimental investigations and results of the actual leakage of a piston valve as a possible source of loss of steam. Ills. 2500 w. Engr, Lond—Feb. 9, 1912. No. 30675 A.

TRANSPORTING AND CONVEYING

Aerial Tramways

Installations for Transporting Minerals on the Isle of Elba, Elba Company (Installations de transbordement des minerais de la Société Elba, à l'Île d'Elbe). An aerial tramway from the mines which empties directly upon ore vessels. Ills. 2400 w. Génie Civil—Jan. 6, 1912. No. 30612 D.

Ash Handling

Cinder Conveyors in the Ouest-Lumière Plants, Puteaux (Appareils de Manutention des Cendres dans les usines de l'Ouest-Lumière, à Puteaux-Seine). Description of derricks and conveyors. Ills. & Plate. 2600 w. Génie Civil—Feb. 3, 1912. No. 30625 D.

See also Ropeway, under *Transporting and Conveying*.

Belts

Belts—How to Select and Manage Them. Owen Linley. Explains the fitting of belts to their work. Ills. 2500 w. Wood Craft—Feb., 1912. No. 30217.

Conveyors

A Study of Mechanical Conveyors. Lincoln DeG. Moss. Extracts from lectures at Columbia Univ. Reviews development and studies types. Ills. 11500 w. Sch of Mines Qr—Jan., 1912. Serial. 1st part. No. 30778 D.

An Electric Hoist Traveler for Placing the Concrete Floor of a Viaduct. C. M. Kurtz. Illustrates and describes details of traveler used on a plate-girder viaduct of the So. Pacific Co. in San Francisco. 1000 w. Eng News—Jan. 25, 1912. No. 30095.

Cranes

The Management and Care of Cranes in Steelworks. Remarks, with specifications for 60-ton electric overhead traveler. 1500 w. Mech Wld—Jan. 26, 1912. No. 30308 A.

Musker and Davison's 2-Ton Compensated Electric Luffing Crane. Illustrations, with brief description. 800 w. Engng—Jan. 26, 1912. No. 30321 A.

New Brakes, Especially for Foundry Cranes (Neue Bremsen, insbesondere für Giessereikrane). Herr Wintermeyer. Recent improvements in crane operation and control. Ills. 1800 w. Giesserei-Zeitung—Feb. 1, 1912. No. 30577 D.

See also same heading, under **MARINE AND NAVAL ENGINEERING**.

Ropeway

Aerial Ropeway for a Shropshire Quarry. Illustrated description of an interesting ropeway recently constructed in Great Britain for transporting stone to the nearest railway. 2500 w. Engr, Lond—Jan. 26, 1912. No. 30325 A.

Tube Carriers

New Tube Carriers and Operating Machinery (Neure Rohrpost- und Rohrpostmaschinenanlagen). H. Kasten. Describes applications of the tube delivery service in shops and dwellings, and explains operation and machinery. Ills. Serial. 1st part. 4500 w. Zeitschr des Ver Deutscher Ing—Jan. 13, 1912. No. 30565 D.

MISCELLANY

Expositions

Thermo-Motors at the International Industrial Trades Exposition, Turin, 1911 (Die Wärmemotoren an der Internationalen Industrie- und Gewerbeausstellung Turin 1911). P. Ostertag. Description of some of the leading types exhibited. Ills. Serial. 1st part. 3000 w. Schweiz Bau—Jan. 27, 1912. No. 30542 D.

Gem Engraving

Gem Engraving. Cecil Thomas. Describes the methods and work of the different periods. Ills. Also discussion. 5800 w. Jour Soc of Arts—Feb. 16, 1912. No. 30776 A.

Igniters

The Application of Pyrophoric Alloys. Illustrates and describes various applications of spark-forming alloys, explaining their defects and advantages in ignition. 1500 w. Sci Am Sup—Feb. 17, 1912. No. 30441.

Knife Manufacture

See Shop Practice, under *Machine Works and Foundries*.

Textile Industry

Recent Progress in Textile Coloring (Les progrès récents de l'industrie tinctoriale). Eug. Grandmougin. Details the operation of producing and coloring mercerized and silk finished cloths, etc. Serial. 1st part. 4800 w. Génie Civil—Jan. 6, 1912. No. 30613 D.

Vacuum Cleaners

Tests of Vacuum Cleaning Tools and Exhausters. M. S. Cooley. Read before the Am. Soc. of Heat. and Vent. Engrs. Describes tests made to determine the requirements of a first-class cleaning system. Ills. 2500 w. Heat & Vent Mag—Feb., 1912. No. 30448.

Waste

Utilizing Waste Materials in the South. James C. Lawrence. Explains some methods used and the products. 2500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30754 D.

MINING AND METALLURGY

COAL AND COKE

Australia

West Australian Coal Industry. H. Allerton Cowper. Describes the Collie deposits and their development, reviewing their history. 3000 w. Aust Min Stand—Jan. 4, 1912. No. 30291 B.

Austria

The Krakau Coal Basin (Das Krakauer Kohlenbassin). Fr. Bartonec. A brief review of the economical situation in the field, discussing the industry, transport tariffs, waterways and the administrative conditions. 3200 w. Oest Zeit f Berg- u Hüttenwesen—Jan. 6, 1912. No. 30517 D.

Baths

Miners' Baths. H. F. Bulman and W. B. Wilson. Information gathered during a visit to some of the newest installations of baths in Westphalia, Belgium, and the north of France. Ills. 3500 w. Ir & Coal Trds Rev—Feb. 16, 1912. No. 30805 A.

China

See same heading, under *Iron and Steel*.

Coaldust

Some Phases of the Coaldust Question. W. Galloway. Presidential address to the So. Wales Inst. of Engrs. Reviews early and recent phases of the question, with investigations of causes of colliery explosions. 4000 w. Col Guard—Jan. 26, 1912. Serial. 1st part. No. 30314 A.

Reports on the French Coaldust Experiments: Fifth Series. J. Taffanel and A. Durr. A review of laboratory tests, the means of ignition consisting of a flame, an electric spark, or a hot surface. 4000 w. Col Guard—Feb. 2, 1912. No. 30400 A.

Coal Fields

Industrial Power in Southern Coal. Edward Wheeler Parker. Information concerning the coal resources, present rate of production, etc. 1800 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30742 D.

The Black Mountain Coal District, Kentucky. J. B. Dilworth. Descriptive account of a little-known coal district, its topography, drainage, mineral resources,

and geologic features. Map. 8000 w. Bul Am Inst of Min Engrs—Feb., 1912. No. 30837 F.

Coal Gas

Present State of the German Coal Gas Industry (L'État actuel de l'Industrie du Gaz d'éclairage en Allemagne). W. Bertelsmann. Discussion on German methods of manufacture. Ills. Serial. 1st part. 5400 w. Technique Moderne—Jan. 1, 1912. No. 30608 D.

Air Gas Fuel in the Main Delitzsch Plant (Die Gasluftheizung in der Hauptwerkstatt Delitzsch). E. Krause. Describes the construction of the plant and mode of operation. Ills. Serial. 1st part. 7500 w. Glaser's Annalen—Jan. 15, 1912. No. 30546 D.

Coke Oven Gas

Coke Oven Gas in Open Hearth Furnaces. From a paper by Prof. O. Simmersbach in *Stahl und Eisen*. Gives results with mixed gases and with oven gas alone. 3000 w. Ir Age—Feb. 8, 1912. No. 30272 C.

Coking By-Products

The Simon-Carves By-Product Recovery Process. Illustrated description of a plant for the recovery of tar and ammonium sulphate from hot coke-oven gas. 2500 w. Ir & Coal Trds Rev—Jan. 19, 1912. No. 30187 A.

Coke-Oven Tars of the United States. Prevost Hubbard. Gives results of analyses of all the coke-oven tars at present manufactured in the United States, with discussion of their properties in relation to their use as road material. 3000 w. U S Dept of Agri, Circ 97—Feb. 7, 1912. No. 30914 N.

Electric Power

Electric Power in South-East Kent. An illustrated account of the development of the extensive coal measures recently found, and the electric plant installed. 2500 w. Elec Rev, Lond—Feb. 16, 1912. No. 30786 A.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, *Generating Stations*.

Explosion

Cross Mountain Mine Explosion. Illustrates and describes this Tennessee mine, its ventilation, the effects of the explosion, and the recovery work. 5500 w. Mines & Min—Feb., 1912. No. 30219 C.

Gas Accumulations

Relieving Accumulations of Gas. W. H. Cunningham, and C. R. Connor. Read before the Min. Inst. of Ky. Explains method of relieving gas pockets by the use of bore holes through which the gas from a lower seam was drawn off. Ills. 2200 w. Mines & Min—Feb., 1912. No. 30222 C.

The Gas Eruption in the Belgian Coal-fields During the Years 1892-1908 (Die plötzlichen Gasausbrüche in den belgischen Kohlengruben während der Jahre

1892-1908). W. Schulz. An account of the eruptions with profiles of the geological formation showing probable causes. Ills. Serial. 1st part. 5200 w. Glückauf—Jan. 13, 1912. No. 30514 D.

Germany

The Formation of the Finefrau Strata in the Witten Bochum Basins (Die Ausbildung des Leitflözes Finefrau in der Wittener und in der Bochumer Hauptmulde). Herrn Kerk sieck and Steinhoff. Report of the geological formation of these regions. Ills. Plate. 3500 w. Glückauf—Jan. 13, 1912. No. 30513 D.

Mine Fires

The Giroux Mine Fire. H. H. Sander-son. Gives facts in regard to the occurrence and the methods of recovery after the fire in this Nevada mine. 2000 w. Mines & Min—Feb., 1912. No. 30227 C.

Reviews of 1911

Coal Mining in the United States in 1911. General review of the anthracite and softer coals, and a report by districts. Also review of foreign operations. 7000 w. Min & Engng Wld—Jan. 27, 1912. (Special.) No. 30080 C.

Trade

Wages and Profits in the Coal Trade. Critical review of statements in a pamphlet entitled "Profits and Wages in the British Coal Trade" (1898-1910), by Thomas Richardson and John A. Walbank. 2000 w. Engr, Lond—Feb. 9, 1912. No. 30674 A.

Washing

Coal Washing (La Lavabilité des charbons). M. Hanappe. Comparisons between washed and unwashed coal. Diagrams. 3500 w. Alliance Industrielle—Jan., 1912. No. 30604 D.

COPPER

Nevada

Report of the Goldfield Consolidated Mines Company. Report for the year ending Oct. 31, 1911. 2500 w. Min & Sci Pr—Feb. 3, 1912. No. 30336.

Reviews of 1911

The World's Copper-Mining Industry in 1911. Review of production and prices. 2500 w. Min & Engng Wld—Jan. 27, 1912. (Special.) No. 30078 C.

Smelting

Problems in Modern Copper Smelting. S. E. Bretherton. Address before the Min. Assn. of Univ. of Calif. Outlines the principles of copper matte smelting and converting. Ills. 3800 w. Min & Sci Pr—Feb. 10, 1912. No. 30431.

Copper Smelting at the Kennett Plant, California. C. A. Tupper. History and recent developments of interest. Ills. 2000 w. Min & Engng Wld—Feb. 10, 1912. No. 30364.

Southern States

The Copper, Lead, and Zinc Industries of the Southern States. C. E. Siebenthal. Information concerning the mines, pro-

duction, and the different deposits worked. 5000 w. *Mfrs' Rec*—Feb. 22, 1912. No. 30748 D.

GOLD AND SILVER

Assaying

United States Assay Offices; Methods of Operation. Describes methods used. 2800 w. *Min & Engng Wld*—Feb. 24, 1912. No. 30772.

Canada

The Silver Fields of Nipissing. Reginald E. Hore. Illustrated description of a portion of this region, its rocks, ores, etc., discussing the origin of the silver deposits, their development, reduction, etc. 8500 w. *Qr Bul of Can Min Inst*—Dec., 1911. No. 30887 N.

Cobalt

What Cobalt Silver Mines Have Done. Alex. Gray. Reviews the records of companies in Cobalt for the year 1911. 5000 w. *Min Jour*—Jan. 20, 1912. No. 30159 A.

Cyaniding

Progress of Cyano-Metallurgy in 1911. The present number reviews stamp milling and regrinding practice, the tendency to favor stage crushing, etc. 3500 w. *Min & Engng Wld*—Feb. 3, 1912. Serial. 1st part. No. 30245.

Electrolytic Oxygen in Cyanide Solutions. T. H. Aldrich, Jr. Describes experiments, and a process of decomposing water by the electric current to furnish oxygen to dissolve silver or gold in cyanide. 1200 w. *Bul Am Inst of Min Engrs*—Feb., 1912. No. 30838 F.

Cyanide-Plant

The Cyanide-Plant at the Treadwell Mines, Alaska. W. P. Lass. Illustrated description of the plant and method of cyaniding, giving results of experimental work. 7500 w. *Bul Am Inst of Min Engrs*—Feb., 1912. No. 30839 F.

Dredges

The Design and Mechanical Features of the California Gold Dredge. Robert E. Cranston. Describes designs commonly used in California, discussing the mechanical features. Ills. 14500 w. *Jour Am Soc of Mech Engrs*—Feb., 1912. No. 30692 D.

Ecuador

Notes on the Geology of the Zarunna Mines, Ecuador. J. G. Baragwanath. Brief description of these gold mines. 1500 w. *Sch of Mines Qr*—Jan., 1912. No. 30779 D.

Enrichment

Secondary Sulphide Enrichment. Horace V. Winchell. The work of surface waters and instances of secondary enrichment are studied. 4500 w. *Eng & Min Jour*—Feb. 17, 1912. No. 30462.

Goldfield

Goldfield Consolidated Report. Information from the annual report for year ending Oct. 31, 1911. 2500 w. *Eng & Min Jour*—Feb. 10, 1912. No. 30354.

Idaho

The Yellow Jacket Mine, Idaho. G. L. Sheldon. Reminiscences of an isolated gold mine, first opened about 1860. The obstacles encountered and methods of surmounting them. 2000 w. *Eng & Min Jour*—Jan. 27, 1912. No. 30086.

Low Grade

Stratton's Independence Mill. T. C. Linderfelt and James K. Stewart. Concentration followed by cyanidation is used in treating low-grade dump material. 2500 w. *Eng & Min Jour*—Feb. 10, 1912. No. 30352.

Mexico

See same heading, under *Miscellany*.

Oregon

Mining Activities in Baker County, Oregon, in 1911. Dennis H. Stovall. Reviews work at the different properties of these gold and silver mines. 2500 w. *Min & Engng Wld*—Feb. 17, 1912. No. 30480.

Placers

Geology of the Breckenridge Placers. Arthur Lakes. Describes the methods used in working them. Ills. 5000 w. *Mines & Min*—Feb., 1912. No. 30226 C.

Refining

Refining of Base Bullion. W. Poole. Abstract of a paper read before the Sydney Univ. Engng. Soc. Describes processes used in softening, desilvering, and refining base bullion at Broken Hill, Aust. Ills. 5000 w. *Mines & Min*—Feb., 1912. No. 30224 C.

Reviews of 1911

The World's Gold and Silver Production in 1911. General review, with statistics of the production in the United States. 3500 w. *Min & Engng Wld*—Jan. 27, 1912. (Special.) No. 30077 C.

Silver Deposits

Minerals Common to Silver Deposits. W. G. Matteson. Considers similarity in mineralogical formations of veins in various silver districts. Ills. 2500 w. *Mines & Min*—Feb., 1912. No. 30228 C.

South Africa

The Past, Present and Future of the Gold-Mining Industry of the Witwatersrand, Transvaal. Frederick Henry Hatch. (James Forrest Lecture.) Plate. 9500 w. *Inst of Civ Engrs*—June 28, 1911. No. 30493 N.

Tonopah

The Geology of the Tonopah Mining-District. Augustus Locke. Illustrated study of the two opposed interpretations of the structure of this Nevada mine. 2500 w. *Bul Am Inst of Min Engrs*—Feb., 1912. No. 30840 F.

IRON AND STEEL

Analysis

Standardizing Rapid Analytical Methods for Steel Works and Other Purposes. W. H. Herdsman. Reviews the principles on which the Ridsdale analoid methods are based and the claims made to increased rapidity and accuracy. Also discussion.

8000 w. Jour W of Scotland Ir & St Inst—Nov., 1911. No. 30898 N.

Blast Furnace Gas

Dust Determination in Blast Furnace Gas (Ueber Staubbestimmungen im Gichtgas). O. Johannsen. Chemical and physical analysis. 2800 w. Stahl u Eisen—Jan. 4, 1912. No. 30502 D.

Blast Furnaces

The Latest Thin-Lined Blast Furnace. Illustrated description of a furnace plant at Cleveland, Ohio, and the special safety devices. 3500 w. Ir Age—Feb. 1, 1912. No. 30191 C.

New Blast Furnace at the Works of the Barrow Hematite Steel Company, Limited. Drawings, photographs and description. 2500 w. Ir & Coal Trds Rev—Jan. 19, 1912. No. 30186 A.

Blast-Furnace Slag

Blast-Furnace Slag; Its Properties and Uses (Eisenhochofenschlacken, ihre Eigenschaften und ihre Verwendung). H. Fleissner. Giving chemical analysis and stating some of the methods of application. Ills. Serial. 1st part. 4000 w. Oest Zeit f Berg- u Hüttenwesen—Jan. 20, 1912. No. 30518 D.

China

Notes on the Han-Yeh-Ping Iron and Coal Company, China. Cho-Yang and Cheng-Fu Wang. Illustrations and brief description of the chief plants. 900 w. Sch of Mines Qr—Jan., 1912. No. 30780 D.

Electro-Metallurgy

Recent Developments in Electric Iron Smelting. Thomas D. Robertson. Describes briefly the process of blast furnace smelting, and considers in detail this new process for the manufacture of pig iron from its ores. Ills. 3500 w. Ap Sci—Feb., 1912. No. 30883 C.

The Electro-Metallurgical and Electro-Siderurgical Plant at Ugine, Savoy (Les Installations électrométallurgiques et électrosiderurgiques d'Ugine, Savoie). Plans and description of hydro-electric foundry on the Arly River. Ills. 8000 w. Technique Moderne—Feb. 1, 1912. No. 30609 D.

Imports

Imports of Foreign Iron Ore in 1911. Information concerning imports from different countries, illustrating loading appliances and methods. 4000 w. Ir Trd Rev—Feb. 1, 1912. No. 30198.

Ingot

Specifications for Composition Ingot. A. P. Ford. Gives specifications believed to be practical and just to both buyer and seller. 1200 w. Brass Wld—Feb., 1912. No. 30473.

Iron Ore

Europe's Supply of Iron Ore. Editorial review of a recent publication by Dr. Th. Sehmer, discussing the subject from the German point of view. 1600 w. Engng—Jan. 26, 1912. No. 30320 A.

Hot Blast Stoves

Regenerative Stoves: Their Relation to Blast Furnace Practice. A. N. Diehl. Considers their design, operation and economical importance. Discussion. 14500 w. Pro Engrs' Soc of W Penn—Jan., 1912. No. 30812 D.

Michigan

Iron River District, Michigan. P. B. McDonald. The ore is medium-soft, red hematite, and requires crushing. Reports rapid development during the last five years. Map. 1200 w. Eng & Min Jour—Jan. 27, 1912. No. 30085.

Norway

Sydvaranger Iron Mines. A. Udhaug. Illustrated description of the ore deposits, mining operations, separation and briquetting plant, etc., with remarks on the future outlook. 3000 w. Ir & Coal Trds Rev—Feb. 2, 1912. No. 30412 A.

Open Hearth Furnaces

Dimensions of Open-Hearth Furnaces. M. A. Pawloff. From a paper in *Stahl und Eisen*. Notes on ordinary gas-fired furnaces, oil-fired furnaces, and mixers and furnaces for continuous operations. 1500 w. Ir & Coal Trds Rev—Jan. 26, 1912. No. 30328 A.

Reviews of 1911

I. Iron and Steel Industry in United States in 1911. II. The World's Iron and Steel Industries in 1911. General reviews with statistics of production, consumption, prices, etc. 8000 w. Min & Engng Wld—Jan. 27, 1912. (Special.) No. 30081 C.

Rolling Mills

Tests for Rolling Mill Power Requirements. B. N. Westcott. Discusses the problem of determining the power for steam engine and electric motor-driven steel mills. 3000 w. Ir Trd Rev—Feb. 15, 1912. No. 30430.

Notes on the Power Required in Wire, Beam and Plate Rolling (Beitrag zur Kenntnis des Kraftbedarfs von Träger-Draht- und Blechstrassen). J. Puppe. Mathematical discussion. Serial. 1st part. Ills. 3500 w. Stahl u Eisen—Jan. 4, 1911. No. 30501 D.

See also Electric Drive, under MECHANICAL ENGINEERING, *Power and Transmission*.

Smelting

See Electro-Metallurgy, under *Iron and Steel*.

Southern States

The Future of the South in the Manufacture of Iron and Steel. John Jermain Porter. Information concerning the ore resources and fuel, discussing advantages and disadvantages affecting manufacture. 3500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30744 D.

Steel

The Production of Sound Steel. Sir Robert A. Hadfield. Explains how material can be produced which will be free

from segregation, blowholes, or piping. Ills. 1500 w. *Ir Age*—Feb. 1, 1912. No. 30192 C.

The Heat Treatment of Steel. James H. Herron. Read before the Metal Trds. Supts. & Foremen's Club of Cleveland. Considers only carbon steels used for manufacturing purposes and from a low carbon content to approximately carbon of 1 per cent. Ills. 2500 w. *Mech Wld*—Feb. 2, 1912. Serial. 1st part. No. 30399 A.

Steel Works

The Minnesota Steel Co.'s New Plant at Duluth. Illustrates and describes features of construction and arrangement. 2000 w. *Ir Trd Rev*—Feb. 8, 1912. No. 30384.

LEAD AND ZINC

Blast-Roasting

On the Theory of Blast-Roasting of Galena. C. O. Bannister. Reviews the various processes that may be classified as blast-roasting and reports experimental research work and conclusions. 12500 w. *Inst of Min & Met*, Bul 89—Feb. 8, 1912. No. 30908 N.

Lead Production

Refined Lead and Spelter in United States in 1911. Review of lead and zinc mining, the production and prices. 2500 w. *Min & Engng Wld*—Jan. 27, 1912. (Special.) No. 30079 C.

Smelting

Zinc Smelting at Trollhattan. Summary of a paper by F. W. Harbord giving an account of the smelting of 537 tons of ore in electric furnaces, with statement of results and cost. 2000 w. *Eng & Min Jour*—Feb. 10, 1912. No. 30353.

Southern States

See also same heading, under *Copper*.

White Lead

Process of Manufacturing Sublimed White Lead. Evans W. Buskett. Detailed description of the process and the machinery and equipment used. Line drawings. 2000 w. *Min & Engng Wld*—Feb. 17, 1912. No. 30477.

Wisconsin

The Wisconsin Zinc District. P. K. Kelley. Considers the production, operation, outlook and needs of this district. Ills. & Map. 1500 w. *Min & Sci Pr*—Feb. 17, 1912. No. 30710.

Zinc Analysis

The Determination of Sulphur in Roasted Blende. C. C. Nitchie. From the *Journal of Ind. & Engng. Chem.* Describes a rapid method which has been in use more than a year. 2000 w. *Min & Engng Wld*—Feb. 10, 1912. No. 30365.

MINING

Aerial Tramways

See same heading, under **MECHANICAL ENGINEERING, Transporting and Conveying.**

Costs

A Note on Mining and Concentrating Costs at Le Roi No. 2 Mines, Rossland, B. C. Ernest Levy. 500 w. *Qr Bul of Can Min Inst*—Dec., 1912. No. 30889 N.

A Statement of Working Costs. A. W. Allen. On costs of treatment in milling and cyaniding work. 800 w. *Min & Sci Pr*—Feb. 3, 1912. No. 30338.

Electric Power

Electrical Power in the Transvaal. Rowland Gascoyne. Illustrates and describes applications of electric power to winding, hauling, etc. 5500 w. *Cassier's Mag*—Feb., 1912. No. 30281 B.

Electricity in Gold Mining. Brief illustrated description of the winding plant of the West Rand Consolidated mines. 1000 w. *Elec Engr*, Lond—Jan. 19, 1912. No. 30152 A.

Explosives

Recent Developments in Explosives. A. E. Anderson. Read at Telluride, Colo. Reviews briefly the development, especially the recent manufacture of powders from nitroglycerine, nitrotoluene and with or without nitrate of ammonia. 5500 w. *Eng & Min Jour*—Feb. 3, 1912. No. 30241.

Investigations of Explosives Used in Coal Mines. Clarence Hall, W. O. Snelling, and S. P. Howell, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by Charles E. Munroe. Ills. 197 pages. Bureau of Mines—Bul 15. No. 30445 N.

Fuse

The Rate of Burning of Fuse, as Influenced by Temperature and Pressure. Walter O. Snelling and Willard C. Cope. On investigation of conditions that cause retardation or acceleration in the rate of burning. 9000 w. Bureau of Mines—Paper 6. No. 30915 N.

Hoisting

Electrical Hoisting Plants on the Witwatersrand. Rowland Gascoyne. Information concerning the power plants, systems, etc. 3500 w. *Min & Engng Wld*—Feb. 10, 1912. No. 30366.

Hygiene

Miners' Phthisis: The Penalty of Neglect. Reviews the progress made in controlling this disease in various mining districts, and the precautions that should be taken. 3500 w. *Min Jour*—Feb. 17, 1912. No. 30790 A.

Objections to the Abuse of Spirituous Liquors in the Rhine-Westphalia Coal Regions (Die Bekämpfung des Missbrauchs geistiger Getränke im rheinisch-westfälischen steinkohlenbergbau). G. A. Meyer. Objections chiefly based on account of tendencies toward premature invalidism among the miners. 4500 w. *Glückauf*—Jan. 20, 1912. No. 30516 D.

Laws

Origin and History of Mining Locations in Mexico. D. A. Richardson. In-

formation concerning the mining laws, past and present. 1800 w. *Min & Engng Wld*—Feb. 10, 1912. No. 30367.

Mine Air

The Estimation of Carbon Dioxide in Mine Air. T. Bryson. Brief description of simple methods used. Ills. 1000 w. *Col Guard*—Jan. 26, 1912. No. 30315 A.

Mining Methods

Mine No. 3, Saline County Coal Co. Oscar Cartlidge. Illustrates and describes a development in So. Illinois, showing method of fireproof construction of shaft, of handling cars, and mining. 2500 w. *Mines & Min*—Feb., 1912. No. 30218 C.

Power Plants

Power for Cobalt Mines, Cobalt, Ontario. Cecil B. Smith. Brief description of plants installed to furnish power for these silver mines. 1200 w. *Jour Assn of Engng Socs*—Jan., 1912. No. 30819 C.

Shafts

Some Interesting Cases of Shaft Sinking. John S. Franklin. Illustrated account of difficulties with water-bearing strata. 3500 w. *Cassier's Mag*—Feb., 1912. No. 30283 B.

Wire Rope

Wire Rope as Applied to Mining. Dugald Baird. Abstract of paper in the *Trans. of the Min. Inst. of Scotland*. Considers different makes of rope, their care, methods of testing, calculations, etc. 4200 w. *Mines & Min*—Feb., 1912. No. 30221 C.

MINOR MINERALS

Barite

The Barite Deposits Near Five Islands, Nova Scotia. Charles H. Warren. Gives the mode of occurrence and probable origin of these deposits. 3000 w. *Ec-Geol*—Dec., 1911. No. 30810 D.

Bauxite

Bauxite Mining in Tennessee. George H. Ashley. From *Resources of Tenn*. Describes minerals yielding aluminum, methods of occurrence and mines in operation. Ills. 2500 w. *Mines & Min*—Feb., 1912. No. 30223 C.

Clays

Clays. Editorial review of recent developments in the scientific study of a basis for a standard clay. 3000 w. *Engng*—Feb. 2, 1912. No. 30401 A.

The Geology and Mining of Clay. Edgar K. Soper. Discusses the formation and classification of clays and the methods of mining. 6000 w. *Eng & Min Jour*—Feb. 3, 1912. No. 30239.

Clay Products and Clay in the South. Jefferson Middleton. A résumé of the clay resources, and information relating to them. 4500 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30749 D.

See also Fuller's Earth, under *Minor Minerals*.

Fuller's Earth

Fuller's Earth in the South. F. B. Van Horn. Explains the clarifying action of

this form of clay, its properties, uses, production, etc. 3500 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30751 D.

Graphite

The Amherst (Quebec) Graphite Deposits. Fritz Cirkel. Describes these Canadian deposits, discussing their origin. Ills. 2500 w. *Qr Bul of Can Min Inst*—Dec., 1911. No. 30888 N.

Molybdenite

Concentration of Molybdenite Ores. Henry E. Wood. Describes three types of concentrators. Ills. 1500 w. *Eng & Min Jour*—Jan. 27, 1912. No. 30087.

Oils

Oils and Oil Testing. Charles A. Mann. Considers methods of production, methods of testing, etc. 1200 w. *Wis Engr*—Feb., 1912. No. 30881 C.

Vast Storehouse of Fuel in Southern Petroleum and Natural Gas. David T. Day. Concerning the production and use and the future development. 3000 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30750 D.

I. Production of Petroleum in the United States, 1911. II. Review of Some Foreign Oil and Gas Fields. Gives review by districts, with statistics of production, prices, etc. 7500 w. *Min & Engng Wld*—Jan. 27, 1912. (Special.) No. 30084 C.

The Spring Valley Oilfield in Southwestern Wyoming. F. J. H. Merrill. Brief illustrated account of this field and the companies now operating. Map. 2000 w. *Min & Sci Pr*—Jan. 27, 1910. No. 30189.

Oilfields

Labor on the Burmese Oilfields. A. M. Finlayson. Information concerning labor conditions. Ills. 2000 w. *Min Mag*—Feb., 1912. No. 30807 B.

Orthoclase

Orthoclase-Bearing Veins from Rawhide, Nevada, and Weehawken, New Jersey. Austin F. Rogers. Describes these two occurrences of vein orthoclase, one a quartz-orthoclase replacement and the other calcite-orthoclase fissure veins. Ills. 2000 w. *Ec-Geol*—Dec., 1911. No. 30809 D.

Phosphate

Phosphate Mining in Relation to the Fertilizer Industry. C. G. Memminger. Considers the phosphate mining industry, and also the fertilizer industry in the south. 3500 w. *Mfrs' Rec*—Feb. 22, 1912. (Special.) No. 30745 D.

Quicksilver

Quicksilver Works in Austria. Extract from M. Von Lipold's article on the Imperial Quicksilver Works, at Idria Krain, Austria. Gives the history of the mines, and methods of preparing and refining the ores. 2500 w. *Mines & Min*—Feb., 1912. No. 30225 C.

Salt

Salt Manufacture in Great Britain. Illustrated description of a new plant work-

ing by vacuum evaporation. 1500 w. Sci Am Sup—Feb. 3, 1912. No. 30267.

Louisiana Salt Mines; Their Operation and Output. Paul Wooton. Brief illustrated description. 800 w. Min & Engng Wld—Feb. 17, 1912. No. 30478.

Zechstein Salt in the Lower Rhine Bottoms (Die Zechsteinsalze des niederrheinischen Tieflandes). W. Wunstorf and G. Fliegel. Discussion of this salt and its production in this region. Ills. 4500 w. Glückauf—Jan. 20, 1912. No. 30515 D.

Tin

Review of the World's Tin Production in 1911. Reviews the production in the various fields. 3500 w. Min & Engng Wld—Jan. 27, 1912. (Special.) No. 30082 C.

Tungsten

Review of the Tungsten Mining Industry in 1911. Statistics of production. 3000 w. Min & Engng Wld—Jan. 27, 1912. (Special.) No. 30083 C.

ORE DRESSING AND CONCENTRATION

Assaying

Quick Combination Methods in Smelter Assays. A. T. French. Presents a scheme worked out by the author which seems capable of quite general application. 5500 w. Inst of Min & Met, Bul 89—Feb. 8, 1912. No. 30909 N.

Chilean Mill

The Slow Speed Chilean Mill. J. B. Empson. Excerpt from a paper before the Mex. Inst. of Min. & Met. Presents the merits of this mill, and data obtained from a specially constructed mill now in use in Siberia. 4000 w. Eng & Min Jour—Feb. 3, 1912. No. 30238.

Crushers

The Large Ore Crusher at the Biwalik Mine. Illustrated description of an electrically driven iron ore breaker which has a capacity of 1000 tons an hour. 1200 w. Ir Trd Rev—Feb. 15, 1912. No. 30429.

Extraction Tests

A Graphic Method of Illustrating the Results of Extraction Tests. H. K. Picard. Suggests a method found particularly suitable when a large number of products result. 500 w. Inst of Min & Met, Bul 89—Feb. 8, 1912. No. 30910 N.

Filters

A Gravity Filter Plant. C. J. Stone. Describes a small plant in Montana, producing low-grade free-gold ore. 1600 w. Eng & Min Jour—Feb. 17, 1912. No. 30463.

Joplin

Ore Dressing in the Joplin District. James L. Bruce. Illustrated analytical review of the ore treatment in this zinc-lead district. 6000 w. Eng & Min Jour—Feb. 24, 1912. Serial. 1st part. No. 30729.

Kalgoorlie

Ore Treatment at the Associated Mine, Kalgoorlie. M. W. von Bernewitz. Describes this improved plant for treating a sulpho-telluride ore by the roasting and

cyanide method. Ills. 3500 w. Min Mag—Feb., 1912. No. 30806 B.

Reduction

Notes on Absorption of Gold by Amalgamated Copper Plates, Cast Iron Retorts and Amalgam Trays. G. H. Stanley and M. Thornton Murray. Reports investigations with the object of ascertaining whether such absorption had taken place and, if so, to what extent. Ills. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1911. No. 30654 E.

Separation

A New Process for the Separation and Grading of Solids Suspended in Liquids. William J. Gee. Describes a mechanical process for separating the solid matter from the water and, in the same operation, grading it. Ills. 8500 w. Jour Soc of Arts—Jan. 26, 1912. No. 30292 A.

Slimes

The Settling of Mill Slimes. D. L. H. Forbes. Considers the characteristics of slime and gives tests with four types, discussing results. 2500 w. Eng & Min Jour—Feb. 24, 1912. No. 30730.

RARE MINERALS

Diamonds

Diamonds in the Belgian Congo. Sydney H. Ball. Information concerning discoveries and prospecting in West Africa. Map. 1200 w. Eng & Min Jour—Feb. 3, 1912. No. 30240.

History of the Diamond Fields of India and Brazil. C. Roe Gardner. Extracts from a lecture before the Min. Sec. of the Brooklyn Inst. of Arts and Sciences. 2500 w. Min & Engng Wld—Feb. 17, 1912. No. 30479.

Deposits

Rare Minerals of the South. Frank L. Hess. Information concerning monazite, zircon, yttrium minerals, rutile, tin, etc. 3500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30753 D.

MISCELLANY

Alaska

Geology and Mines of the Sitka District, Alaska. Adolph Knoff. Maps and description of this region. 3500 w. Min & Engng Wld—Feb. 24, 1912. Serial. 1st part. No. 30771.

British Columbia

Metallurgy in British Columbia in 1911. E. Jacobs. Review of progress made in separating metals from their ores. 8500 w. Can Min Jour—Feb. 1, 1912. No. 30249.

German Associations

The Growth of German Iron and Steel Associations in 25 Years (Die Entwicklung der deutschen Eisen- und Stahl-Berufsgenossenschaften in 25 Jahre). Herr Meesmann. Gives statistics of the growth of the eight associations. 3000 w. Stahl u Eisen—Jan. 4, 1912. No. 30500 D.

Laboratories

Mining and Metallurgical Laboratories at Wisconsin. Edwin C. Holden. Illus-

trated description. 2000 w. Wis Engr—Feb., 1912. No. 30882 C.

The Fritz Engineering and the Coxe Mining Laboratories of Lehigh University. Joseph Daniels. Illustrated descriptions. 2000 w. Bul Am Inst of Min Engrs—Feb., 1912. No. 30841 F.

Mexico

Mining in Mexico. T. Lane Carter. An estimate of present and future conditions. Ills. 6000 w. Engineering Magazine—March, 1912. No. 30836 B.

Alamos District, Sonora, Mexico. G. L. Sheldon. Descriptive account of the district and its mines. Ills. 2000 w. Min & Sci Pr—Feb. 3, 1912. No. 30339.

New Zealand

Mining Ore at the Talisman Mine, N. Z. Arthur Jarman. Abstract from a paper to the Aust. Inst. of Min. Engrs. Describes the geology of the reef, methods of mining and handling the ore, the pumping machinery, etc. Ills. 6500 w. Mines & Min—Feb., 1912. No. 30229 C.

Nicaragua

Geology of the Pis Pis Mining District in Nicaragua. Oscar H. Hershey. Descriptive. 3000 w. Min & Sci Pr—Feb. 17, 1912. No. 30709.

Ore Deposits

Some Features of Replacement Ore-Bodies and the Criteria by Means of which They May Be Recognized. J. D. Irving. Historical review, followed by descriptions and discussion of such deposits. Ills. 20500 w. Qr Bul of Can Min Inst—Dec., 1911. No. 30886 N.

Types of Ore Deposits—A Review. A. C. Lawson. Reviews a book consisting of

a collection of papers by different authors. 3000 w. Min & Sci Pr—Feb. 3, 1912. No. 30337.

Western Portion of the Torbrook Iron Ore Deposits. Howells Fréchette. Report of surveys of this Nova Scotia field, describing the nature of the ore and the development. Ills. & Map. 2500 w. Can Dept of Mines—Bul No. 7. No. 30890 N.

Profits

See Mining Profits, under INDUSTRIAL ECONOMY.

Reviews of 1911

Metal Production and Prices in 1911. L. Vogelstein. Gives statistics of productions and prices in the American metal market as summarized by this company. 2000 w. Min & Sci Pr—Jan. 27, 1912. No. 30190.

South Dakota

Analyses of Some Rocks and Minerals from the Homestake Mine, Lead, South Dakota. W. J. Sharwood. Gives analyses showing the chemical composition of the different rocks associated with the ores, and also the minerals of ore. Ills. 1500 w. Ec-Geol—Dec., 1911. No. 30808 D.

Statistics

Our Mineral Statistics. A review of Part III., "Output," of the Mines and Quarries General Report and Statistics for 1910. Information concerning the year's output in Great Britain. 3000 w. Engr, Lond—Jan. 19, 1912. No. 30180 A.

Wastes

Our Mineral Wastes; the Chemist's Opportunity. Charles L. Parsons. Abstract of address before the Am. Chem. Soc. Calls attention to waste in various fields and discusses methods of conservation. 3500 w. Min & Engng Wld—Feb. 24, 1912. No. 30770.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Canada

Canada's Transportation Problem. E. B. Biggar. A discussion of railway economics and problems of the service, and the subject of government ownership. 2000 w. Can Engr—Jan. 25, 1912. No. 30107.

Regulator

Tirrill Regulator on the Mersey Railway. Illustrated detailed description, with an account of a particular application. 1700 w. Engng—Feb. 2, 1912. No. 30402 A.

Signalling

Annual Report of Block Signal Board. Information from the fourth report of the block signal and train control board, issued by the Interstate Commerce Commission. 5000 w. Ry Age Gaz—Feb. 2, 1912. No. 30200.

The Use of Electricity for the Control of Railways. J. E. Sayers. Abstract of paper

read before the Derby Soc. of Engrs. Describes the methods used on the Midland Railway, England, in which the telephone is extensively used. 1800 w. Elect'n, Lond—Jan. 19, 1912. No. 30157 A.

Upper Quadrant Signal in Great Britain. J. F. Gairns. Illustrated description of the system. 1000 w. Bul Int Ry Cong—Feb., 1912. (Part 2.) No. 30893 G.

The Rudiments of Block Systems (Eine Ergänzung am Anfangsfelde der Blocklinien). R. Edler. The Underlying principles in the control and operation of block systems in various aspects. Ills. Serial. 1st part. 4200 w. Elek u Masch—Jan. 7, 1912. No. 30520 D.

Speed

Railway Speed in 1911. Gives tables of British and French railway speed, with remarks. 800 w. Engr, Lond—Jan. 19, 1912. No. 30182 A.

Train Despatching

Telephony in the Train Service of the United States (La telephonie dans le service des trains aux Etats-Unis). H. Marchand. Describes the growing use of the telephone in train despatching. Diagrams. 7500 w. L'Electricien—Jan. 13, 1912. No. 30605 D.

MOTIVE POWER AND EQUIPMENT**Air Brakes**

See Brake Valves, under *Motive Power and Equipment*.

Balancing

A Contribution to the Theory of the Balance Weights of Locomotives. J. Jahn. A discussion of the problem of balancing and its solution. 6600 w. Bul Int Ry Cong—Feb., 1912. (Part 2.) No. 30895 G.

Boilers

Butt-Riveted Joints in Locomotive Boilers (Lokomotivkessel-Laschennietungen). J. Kempf. Treats of the mathematics of stress determination in rivets in three modes of joints. Ills. 3000 w. Glaser's Annalen—Jan. 15, 1912. No. 30547 D.

Brakes

Mr. H. Sabouret's New Method of Applying Continuous Brakes on Long Goods Trains. Describes the method. 3000 w. Bul Int Ry Cong—Feb., 1912. (Part 2.) No. 30894 G.

Brake Valves

Wrongly Used Triple Valves. Explains the effect of using wrong valves, confining the discussion to freight cars. 2000 w. Ry & Loc Engng—Feb., 1912. No. 30140 C.

The Type L Brake Valve. Gives views of the N. Y. Air Brake Co.'s type L brake valve, explaining its operation. 700 w. Ry & Loc Engng—Feb., 1912. No. 30141 C.

Fuel Purchasing

Purchasing Locomotive Fuel. R. D. Quinckel. Abstract of a paper read before the Min. Inst. of Ky. Considers the qualities necessary for a good locomotive coal and other conditions determining values. 2500 w. Mines & Min—Feb., 1912. No. 30220 C.

Locomotives

The 50,000th Locomotive of the American Locomotive Co. Illustrated detailed description of an experimental Pacific type designed to provide the maximum power per pound of weight. 2500 w. Mach (Ry Ed)—Feb., 1912. No. 30313 C.

Mikado Locomotives for Heavy Freight Service. Illustrates and describes the heaviest Mikado yet built, to be placed in service of the C. & O. Ry. 1200 w. Ry Age Gaz—Feb. 2, 1912. No. 30201.

Mikado Type Locomotive for the Chesapeake & Ohio Ry. Illustrated description of an engine designed to haul 4,000 tons on a 0.3 per cent grade at a speed of 15 miles per hour. 2000 w. Ry & Engng Rev—Feb. 10, 1912. No. 30380.

Mikado Locomotives for the Erie. Illustrated detailed description of new engines

and the service they were designed to meet. 1000 w. Ry Age Gaz—Feb. 9, 1912. No. 30362.

Mikado Type Locomotives for the Erie Railroad. Illustrated detailed description of recently completed engines. 800 w. Ry & Engng Rev—Feb. 3, 1912. No. 30260.

Six Coupled Express Passenger Locomotive, Great Eastern Railway. Illustration of new 4—6—0 engine, with brief description. 300 w. Ry Gaz, Lond—Feb. 9, 1912. No. 30660 A.

1000 B. H. P. Crude Oil Locomotive. Drawings and description of the Dunlop adiabatic closed-circuit air-transmission system. 3500 w. Mech Engr—Jan. 19, 1912. No. 30161 A.

Locomotive Smoke

Prevention of Smoke. T. A. Lawes. Illustrates and describes the equipment the writer considers necessary to prevent the emission of dense smoke. 1500 w. Ry & Loc Engng—Feb., 1912. No. 30139 C.

Tests in Smoke Abatement on Santa Fe Switching Locomotives. Reports tests of a Chicago committee made to obtain an exact record of smoke from switching engines in service, and the size of cinders thrown out. Ills. 2500 w. Ry Age Gaz—Feb. 23, 1912. No. 30725.

Repair Shop Costs

Workshop Costs in the Repair of Locomotives and Cars on American Railways (Werkstattkosten und -hilfskräfte für die Ausbesserung der Lokomotiven und Wagen bei einer amerikanischen Eisenbahnverwaltung). Bruno Schwarze. Discusses American cost account practices on leading roads. Serial. 1st part. 3000 w. Glaser's Annalen—Feb. 1, 1912. No. 30549 D.

Rolling Stock

Standard Materials for Railway Rolling-Stock. Editorial review of reports of the Engineering Standards Committee. 1500 w. Engng—Feb. 9, 1912. No. 30673 A.

Shops

Extension of the Locomotive Department at Ashford. Plan and description of additional shops for the South-Eastern and Chatham Railway. 1200 w. Engr, Lond—Feb. 9, 1912. No. 30677 A.

Tires

See Boring Machines, under **MECHANICAL ENGINEERING, Machine Works and Foundries**.

Trailers

Pittsburgh Trailers and Their Lessons. John P. Fox. Illustrated description of trailers used, providing 62 seats, and, with the motor car, 119 seats. 1500 w. Sci Am—Feb. 24, 1912. No. 30738.

Trains

Vestibuled Corridor Trains. Illustrated description of a finely equipped train on the London, Tilbury & Southend Ry. 400 w. Ry Gaz, Lond—Jan. 26, 1912. No. 30311 A.

NEW PROJECTS

Alaska

Construction of the Copper River & Northwestern. Illustrated account of the construction of a railway from the coast to the interior of Alaska. 4000 w. Ry Age Gaz—Feb. 2, 1912. No. 30199.

Baghdad Ry.

The Baghdad Railway. Percy F. Martin. A letter considering the British policy and German and American interests. 1500 w. Ry Gaz, Lond—Feb. 9, 1912. No. 30661 A.

Canton-Hankow

The Kwangtung Section of the Canton-Hankow Railway. An illustrated account of the construction and operation of the portion of the line completed. 6000 w. Far East Rev—Dec., 1911. No. 30290 N.

Chile

The Longitudinal Railway of Chile. Illustrations, sections and description of heavy railway construction in progress with history of the scheme. 1600 w. Engr, Lond—Jan. 19, 1912. No. 30179 A.

China

The Tcheng T'ai Line of the Chinese Imperial Railway Co. (Compagnie Impériale des Chemins de Fer Chinois Ligne du Tcheng T'ai). M. G. Millorat. Description of line and history of construction. Plate. 7000 w. Mem Soc Ing Civ de France—Nov., 1911. No. 30594 D.

See also Canton-Hankow, under *New Projects*.

Italy

The Rome-Ostia Railway (Ferrovia Roma-Ostia). Luigi Botto. An account of the construction of the line with its tunnels in Rome, and its commercial possibilities. Ills. Maps and Plates. 5000 w. Ann della Soc d Ing e d Arch Ital—Dec. 1, 1911. No. 30631 E.

Panama R. R.

Gold Hill Relocation of Panama Railroad. Abstract from the annual report of the Isthmian Canal Commission illustrating and describing the work. 1500 w. Ry Age Gaz—Feb. 16, 1912. No. 30456.

Transandine

The First Trans-Continental Railway in South America, from the Atlantic to the Pacific. F. C. Coleman. Illustrations, with brief description of the Transandine railway and tunnel. 1500 w. Sci Am—Jan. 27, 1912. No. 30061.

PERMANENT WAY AND BUILDINGS

Bridges

See Bridges, under CIVIL ENGINEERING.

Carhouse

Middletown Carhouse of the Connecticut Company. Illustrates and describes a combined carhouse and shop. 1200 w. Elec Ry Jour—Feb. 3, 1912. No. 30250.

Coaling Stations

A Reinforced Concrete Locomotive Coaling Station. Plan, elevation, and description of a station replacing a wooden structure on the B. & O. Ry. at Deshler,

O. 2000 w. Eng Rec—Feb. 3, 1912. No. 30256.

Embankments

Methods of Embankment Protection. From the report of a committee to the Am. Ry. Bridge & Bldg. Assn. Illustrated detailed description of practice. 6000 w. Ry & Engng Rev—Jan. 27, 1912. Serial. 1st part. No. 30073.

Maintenance

Winter Maintenance Difficulties on Northern Railways. E. R. Lewis. Remarks on the preparations necessary and devices used to keep the tracks clear of snow. 3000 w. Ry Age Gaz—Feb. 16, 1912. No. 30459.

Rails

Limit of Endurance of Steel Rails Reached? Report submitted by James E. Howard to the Interstate Commerce Commission. Ills. 6500 w. Ir Trd Rev—Feb. 8, 1912. No. 30335.

Steel Rail Controversy Rapidly Reaches Crisis. An account of the meeting of makers and users in New York. 2000 w. Ir Trd Rev—Feb. 22, 1912. No. 30708.

The Broken Lehigh Valley Rail. Abstract of the report issued by the Interstate Commerce Commission on the accident at Manchester, N. J., Aug. 25, 1911, caused by a broken rail. Also editorial. Ills. 6000 w. Ry Age Gaz—Feb. 16, 1912. No. 30455.

Super-Elevation

See Accelerometer, under CIVIL ENGINEERING. *Measurement*.

Switch Designs

Novelties in Switch Design. Mr. Schmitt. Illustrates and describes the spring tongue switches. 2700 w. Bul Int Ry Cong—Jan., 1912. No. 30130 G.

Terminals

Winter Work on Terminals. F. E. Crabbs. Gives experience at the C. & N. W. terminal in Chicago. 1200 w. Ry Age Gaz—Feb. 16, 1912. No. 30461.

Forbes Street Terminal of the Pittsburgh Railways. Illustrated description of an operating terminal where the carhouse proper and transportation offices are separate structures. 1200 w. Elec Ry Jour—Feb. 10, 1912. No. 30378.

Division Terminal Improvements, C., M. & St. P. Ry., at Aberdeen, S. Dak. Illustrated detailed description of structures and plant. 2500 w. Ry & Engng Rev—Feb. 17, 1912. No. 30486.

Ties

The Life of Wooden and Iron Transverse Sleepers. Mr. Cauer. An account of Mr. Biedermann's investigations and some of their important results. 28000 w. Bul Int Ry Cong—Feb., 1912. (Part 2.) No. 30896 G.

Arrangements for Piling Ties. J. H. Waterman. Abstract of address before the Wood Preservers' Assn. Illustrates and describes a proposed layout for a tie yard.

1800 w. Ry Age Gaz—Feb. 16, 1912. No. 30458.

Track Reconstruction

Closing the Breaches on the Line from Tours to Nantes Produced by the Latest Flood of the Loire (De la Fermeture des Bpêches Produites sur la Ligne de Tours a Nantes par la dernière Crue de la Loire). M. G. Liébeaux. Description of flood and work of reconstruction. Ills. and Plates. 11000 w. Rev Gen des Chemins de Fer—Jan., 1912. No. 30598 G.

Tracks

Standard Designs in Concrete Track Structures, Baltimore and Ohio Railway. Brief illustrated description. 500 w. Engng & Con—Feb. 28, 1912. No. 30865.

Track Scales

Track Scale on the Baltimore and Ohio. L. D. Davis. Illustrates and describes the design adopted and the method of installation. 1500 w. Ry Age Gaz—Feb. 16, 1912. No. 30454.

Tunnels

New Kingswood Tunnel, B. & O. R. R. Illustrated description of the construction of a new double-track tunnel in W. Va. 2500 w. Eng News—Feb. 22, 1912. No. 30723.

Driving the New Kingswood Railroad Tunnel at the Allegheny Summit. E. M. Graham. Illustrated account of a double-track bore on the B. & O. which advanced 4,211 feet in 13 months. 3000 w. Eng Rec—Feb. 10, 1912. No. 30344.

Yards

The Economic Organization and Maintenance of the Freight Car Repair Yard at a Terminal Point. J. Thomas Warde. Read before the W. Can. Ry. Club. Suggestions for the location and equipment of such yards. 1600 w. Can Engr—Jan. 25, 1912. No. 30106.

TRAFFIC

Car Interchange

Joint Car Interchange Bureau at Chicago. An account of a plan designed to facilitate the interchange and reporting the interchange and reporting of cars at large terminals. 3000 w. Ry Age Gaz—Feb. 9, 1912. No. 30361.

Freight Rates

Different Classes of Competition Resulting in the Making of Railroad Freight Rates. T. C. Powell. Explains features that make up the rates of freight, showing the difficulties in the adjustment. 4000 w. Pro St. Louis Ry Club—Jan. 12, 1912. No. 30498.

Tonnage Rating

The Effect of Cold Weather Upon Tonnage Rating. Edward C. Schmidt. Presents results of investigations to determine the increase in train resistance and discusses current practice of American railroads in reducing tonnage ratings during cold weather. Discussion. 8500 w. Pro Cent Ry Club—Jan. 11, 1912. No. 30497 C.

Waterways Competition

Railways and Waterways. Sectional Discussion. The investigation of the influence of waterways, considered as feeders and as competitors, on railways. 14200 w. Bul Int Ry Cong—Feb., 1912. (Part 2.) No. 30891 G.

MISCELLANY

Canada

Canadian Railways in 1911. J. L. Payne. A report of progress during the year ending June 30, 1911. 2500 w. Ry Age Gaz—Feb. 9, 1912. No. 30363.

Development

How Railroads Aid Industrial Development. Francis Washburn Hoadley. Reviews the work of the Delaware & Hudson Company. Ills. 2500 w. Cassier's Mag—Feb., 1912. No. 30289 B.

Possibilities of Railroad Expansion in the Southwest. B. F. Yoakum. Discusses the future outlook and development in connection with the opening of Panama Canal. 2500 w. Mfrs' Rec—Feb. 22, 1912. (Special.) No. 30752 D.

Forest Fires

See Timber, under CIVIL ENGINEERING, *Materials of Construction*.

Philippines

Philippine Railways. A report of the year ending June 30, 1911. Map and Ills. 3500 w. Far East Rev—Jan., 1912. No. 31011 N.

Regulation

Railway Regulation. Walter L. Ross. Abstract of an address before the Traffic Club of Phila. Discusses some of the problems and the work of the Interstate Commerce Commission. 2500 w. Ry Age Gaz—Feb. 23, 1912. No. 30724.

The Relation of Railroads as Common Carriers to the State and Federal Governments. James C. Davis. Gives a brief summary of the rapid development of railways in America, discussing problems relating to their control. General discussion. 8500 w. Jour W Soc of Engrs—Jan., 1912. No. 30813 D.

Siam

The Royal State Railways of Siam. Information from a recent report on traffic conditions of the different lines for the year ending March 31, 1911. Ills. 1800 w. Far East Rev—Jan., 1912. No. 31009 N.

Statistics

Comparative Railway Statistics of the United States, the United Kingdom, France, and Germany for 1900 and 1909. 47 pages. Bureau of Ry Economics—Bul 24. No. 30131 N.

Valuation

The Principles Governing a Railroad Appraisal of an Unusual Nature. Gives an outline of the views of George F. Swain on the valuation of the N. Y., N. H., and H. R. R. 6000 w. Eng Rec—Feb 17, 1912. No. 30465.

STREET AND ELECTRIC RAILWAYS

Cable Railways

The New Varese Funicular of the Varese Electric Construction Company (Le nuove funicolari della Società Varesina per Imprese Elettriche di Varese). A. Sculati. Describes the lines to Campo del Fiori and to Sacro Monte, the equipment of the road, and the power plant. Ills. 6300 w. Ingeg Ferro—Jan. 1, 1912. No. 30640 E.

Cars

Petrol-Driven Tramway Car. Illustrated description of a car used on a short line in England. 1000 w. Engr, Lond—Jan. 19, 1912. No. 30185 A.

Electric Traction

Notes on the Wheeling (W. Va.) Traction Company. Illustrates and describes improvements and extensions. 3500 w. Elec Ry Jour—Jan. 27, 1912. No. 30089.

Electrification

The London, Brighton, and South Coast Railway Electrification. Introductory to a series of articles describing in detail this single-phase system. Ills. 2000 w. Engng—Jan. 26, 1912. Serial. 1st part. No. 30316 A.

The Electrification of a Portion of the Suburban System of the London, Brighton, and South Coast Railway. Philip Dawson. With an abstract of the discussion. Illustrated description of the work and statement of results. Plates. 174 pages. Inst of Civ Engrs—March 14, 1911. No. 3929. No. 30489 N.

Electrification of the Lauban-Königszell Line. Particulars concerning the projected electrification of this line and its branches in the mountainous districts of Prussia. Ills. 1800 w. Ry Gaz, Lond—Feb. 9, 1912. No. 30662 A.

Reviews on the Electrification of Main Lines (Rundschau über die Elektrifizierung von Vollbahnen). W. Reichel. Discusses the electrification of some of the German railways. Ills & Maps. Serial. 1st part. 2800 w. Elek Kraft u Bahnen—Jan. 14, 1912. No. 30582 D.

The Electrification of the Dessau-Bitterfeld Line (L'Elettrificazione della linea Dessau-Bitterfeld.) Civalleri. Describes the route traversed and equipment of the line. Ills. and Map. Serial. 1st part. 2100 w. Industria—Jan. 28, 1912. No. 30638 D.

Holland

Statistics of Electric Tram Operation in Holland for the Year 1910 (Statistiek van Electriche Tramondernemingen in Nederland voor 1910). Giving routes, mileage, passengers carried, costs, etc., for the year. 4 pages. Ingenieur—Jan. 18, 1912. No. 30591 D.

Locomotives

Lötschberg Electric Locomotive No. 121. Illustrates and describes the most notable locomotive in use at present on the portion of this line which is open for traffic. 2500 w. Engr, Lond—Feb. 2, 1912. Serial. 1st part. No. 30408 A.

Motor Cars

Self-Propelled Cars. W. B. Potter. Discusses the present state of development of such cars, the cost of operation, maintenance, etc. Also general discussion. Ills. 10000 w. Pro N Y R R Club—Jan. 19, 1912. No. 30646.

Petrol Cars

Petrol Tramway Cars at Morecambe. Illustrates and describes the first application, in England, of the Leyland motors to tramway service. 3000 w. Tram & Ry Wld—Feb. 8, 1912. No. 30726 B.

Progress

Critical Comparisons on the Use and Growth of Street Railways (Ein Kritischer Vergleich über Benutzung und Ausbreitung von strassenbahnen). Ph. Scholtes. Comparison of traffic, etc., in several German cities. Diagrams. Serial. 1st part. 1200 w. Elek Kraft u Bahnen—Jan. 14, 1912. No. 30583 D.

Rail Resistances

Experimental Studies on the Resistance of Steel Rails to Alternating Currents (Étude expérimentale sur la Résistance des Rails d'Acier, en Courant alternatif). M. C. Villiers. Advances theories from experiments. Discussed by M. Boucherot. 5500 w. Bul Soc Int d'Electriciens—Dec., 1911. No. 30599 F.

Subways

New York's First Subway. Waldemar Kaempfert. Illustrated description of the pneumatic railway built in 1869 by Alfred E. Beach, beneath Broadway, near Warren St. 1800 w. Sci Am—Feb. 24, 1912. No. 30739.

The Cambridge Subway. L. E. Moore. Map and outline of the transit situation as it now exists in Boston, and illustrated detailed description of the location and design of this new subway, its construction, and related subjects. 6500 w. Eng News—Feb. 1, 1912. No. 30232.

Construction of the Metropolitan Railway, Paris (Construction du Chemin de fer Metropolitan). L. Biette. Description of subway construction. Ills. and Plate. 2800 w. Technique Moderne—Jan. 1, 1912. No. 30607 D.

Tunneling the Rue des Italiens, Paris (Le percement de la Rue des Italiens, a Paris). A. Bidault des Chaumes. Details of this underground passage construction. Ills. and Plate. Serial. 1st part. 5600 w. Génie Civil—Jan. 27, 1912. No. 30620 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; H, of \$1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first instalment.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or \$1.00 a year; to non-subscribers, 25 cents per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m*. Brussels.
American Architects. *w*. New York.
American Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brickbuilder. *m*. Boston.
Builder. *w*. London.
Bull. Bur. of Standards. *qr*. Washington.

Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. of Can. Min. Inst. *qr*. Montreal.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m*.
Liège.
Bull. Tech. de la Suisse Romande. *s-m*. Lausanne.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Cassier's Magazine. *m*. New York and London.
Castings. *m*. Cleveland, O.
Cement. *m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Commercial Vehicle. *m*. New York.

- Compressed Air. *m.* New York.
 Consular Reports. *m.* Washington, D. C.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineer. *w.* London.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering-Contracting. *w.* New York.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Cold Storage. *m.* London.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Jour. N. E. Water Works Assn. *gr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *gr.* London.
 Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Métallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal and Engineer. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *gr.* Philadelphia.
 Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *gr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Public Works. *gr.* London.
 Quarry. *m.* London.
 Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Loc. Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Gén. des Chemins de Fer. *m.* Paris.
 Revue Gén. des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
 Signal Engineer. *m.* Chicago.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *gr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD of NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Accounting

Factory Accounts. By Emile Garcke and J. M. Fells. Size 8 by 5 in.; pp., 292. Price, \$2.50. London: Crosby, Lockwood & Son. New York: McGraw-Hill Book Company.

A handbook for accountants and manufacturers with appendices on the nomenclature of machine details, the Income Tax acts, the rating of factories, etc.

Biography

Who's Who in Science. By H. H. Stephenson. Size 9 by 5½ in.; pp., 323. Price, \$2.00. New York: The Macmillan Company.

A biographical index of some of the leading men in the various sciences, including a partial list of the universities of the world and their staffs.

Bridges

A History of Bridge Engineering. By Henry Grattan Tyrrell. Size 9 by 6 in.; pp., 478. Ills. Price, \$4.00. Chicago: H. G. Tyrrell.

An interesting study of the history of bridge construction from the earliest types recorded in the Egyptian and Babylonian period down through the ages to the most modern reinforced concrete bridge. Of interest not only to the engineering profession as a study, but also to the non-technical reader as a history.

Suspension Bridges and Cantilevers. By D. B. Steinman. Size 6 by 3¾ in.; pp., 185. Price, \$0.50. New York: D. Van Nostrand Company.

This latest addition to the Van Nostrand science series presents data on the relative adaptability of cantilever and suspension bridges for long spans, and the limiting spans for which either are suitable.

Claims

Claims: Fixing Their Values. By George F. Deiser and Frederick W. Johnson. Size 8½ by 6 in.; pp., 158. Price, \$2.00. New York and London: McGraw-Hill Book Company.

Of particular interest to the claim adjuster, mentioning points of legal standing by which he may determine the just valuation of claims.

Conduits

The Precise Calculation of Pipe Drain and Sewer Dimensions. By C. E. Housden. Size 7 by 5 in.; pp., 53. Ills. Price, \$1.00. New York and London: Longmans, Green & Co.

A brief work presenting a series of hydraulic tables by means of which safe minimum dimensions and lowest costs on pipes, drains and sewers may be determined.

Dredges

Dredges and Dredging. By Charles Prelini. Size 9 by 6 in.; pp., 279. Ills. Price, \$3.00. New York: D. Van Nostrand Company.

Reviews the fundamentals of dredging, discusses methods of soil and rock dredging and presents points on the proper selection of dredges for varying purposes.

Graphic Statics

A Short Course in Graphic Statics. By William Ledyard Cathcart and J. Irvin Chaffee. Size 7½ by 5 in.; pp., 183. Price, \$1.50. New York: D. Van Nostrand Company.

The treatment of the subject is restricted mainly to the properties and general uses of the force and equilibrium problems, being sufficient for most of the problems met in practice.

Hand-Forging

Hand-Forging and Wrought-Iron Ornamental Work. By Thos. F. Googerty. Size 8 by 5½ in.; pp., 197. Ills. Price, \$1.00. Chicago: Popular Mechanics Company.

For the use of instructors in manual training and others interested in this subject. Presenting designs and drawings with instructions for working them out.

Heating

A Practical Manual of Steam and Hot-Water Heating. By Edward Richmond Pierce. Size 8½ by 5½ in.; pp., 339. Ills. Price, \$2.50. Chicago: Domestic Engineering Company.

Primarily intended for the use of the workman in the heating industry, but also adapted to the technical student.

Ignition

Electric Ignition for Combustion Motors. By Forrest R. Jones. Size 9 by 6 in.; pp., 438. Ills. Price, \$4.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

For the use of persons unfamiliar with electrical devices this book explains the fundamental principles of ignition and describes commercial appliances for all classes of combustion motors ranging from motor cycles to large gas engines.

Lettering

The Essentials of Lettering. By Thomas E. French and Robert Meiklejohn. Size 6 by 9 in.; pp., 94. Ills. Price, \$1.00. New York and London: McGraw-Hill Book Company.

A manual for the use of designers and students in engineering. Giving the essential elements in the study, and also the principles for artistic lettering.

Metallurgy

The Metallurgy of Iron and Steel. By Bradley Stoughton. Size 9 by 6 in.; pp., 537. Ills. Price, \$3.00. New York and London: McGraw-Hill Book Company.

A revised and enlarged edition of a former work embracing the more recent development of the subject, especially those chapters treating on the open-hearth processes, electric smelting, etc.

La Métallurgie du Fer. By Paul Doumer. Size 9 by 5½ in.; pp., 247. Price, \$2.50. Paris: Librairie Vuibert.

A collaboration by the author and others showing the present situation in the metallurgy of iron throughout the largest producing countries of the world.

Physics

A Laboratory Manual of Physics and Applied Electricity. Vol 1. By Edward L. Nichols and Ernest Blaker. Size 9 by 6 in.; pp., 417. Ills. Price, \$3.00. New York: The Macmillan Company.

Revised and rewritten from the original work published in 1894, containing changes in the treatment of many experiments and adding many new ones to the list. This volume is primarily for the junior course in general physics.

Storage Batteries. By Harry W. Morse. Size 7¼ by 5 in.; pp., 266. Ills. Price, \$2.50. New York: The Macmillan Company.

A study of the chemistry and physics of accumulators in general but with particular reference to the galvanic cell.

The Kingdom of Dust. By J. Gordon Ogden. Size 6¾ by 4¾ in.; pp., 116. Ills. Price, \$0.50. Chicago: Popular Mechanics Company.

A popular description of the properties of dust as present in the ordinary elements, describing its effect in the atmosphere, and the effect of the elements upon it.

Power Plants

Steam Power Plants. By Henry C. Meyer, Jr. Size 9 by 6 in.; pp., 219. Ills. Price, \$2.00. New York and London: McGraw-Hill Book Company.

Points on the design and construction of steam-power plants for the benefit of manufacturers and others who may not be posted on the necessary machinery for such plants.

Refrigeration

Refrigeration, Cold Storage and Ice-Making. By A. J. Wallis-Taylor. Size 9 by 6 in.; pp., 632. Ills. Price, \$4.50. New York: D. Van Nostrand Company.

This book presents the details of the various systems of refrigeration and ice-making in use to-day. With descriptions of the machines and appliances involved, preceded by a brief résumé of the theory of refrigeration.

Sociology

The Factory. By Jonathan Thayer Lincoln. Size 7½ by 5 in.; pp., 109. Price, \$1.00. Boston: Houghton Mifflin Company.

Treating on the sociologic side of the factory laborer, and intended to promote a better understanding by the employer of the employee.

Structures

The Elements of Structures. By George A. Hool. Size 9 by 6 in.; pp., 188. Ills. Price, \$1.75. New York and London: McGraw-Hill Book Company.

Intended solely as a textbook in correspondence-study, and is a prerequisite course to all the regular structural engineering studies offered by the Extension Division of the University of Wisconsin.

Telephony

Telephony. By Samuel G. McMeen and Kempster B. Miller. Size 9½ by 6½ in.; pp., 948. Ills. Chicago: American School of Correspondence.

A very complete work on the subject of vocal communication from its inception to the present uses, explaining all of the instruments and operations in modern use equally intelligibly and concisely for both the layman and the technical electrician.

Thermodynamics

Heat and Thermodynamics. By F. M. Hartmann. Size 9 by 6 in.; pp., 346. Ills. Price, \$3.00. New York and London: McGraw-Hill Book Company.

A textbook on the fundamental principles of heat measurements with an aim to keep within the bounds of elementary calculus.

Year Book

The American Year Book. Edited by Francis G. Wickware. Size 8 by 5 in.; pp., 863. Price, \$3.50. New York and London: D. Appleton & Co.

An annual review of events and progress in Statistics, History and Politics, Government, Economics and Sociology, Public Works, Industry, Science and Engineering, the Humanities. Prepared under general direction of a Supervisory Board representing about forty learned societies. Second year, showing marked improvement in analysis of topics and allotment of space.



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No. 2

SIR DAVID DALE; IRON MASTER, CONCILIATOR, ARBITRATOR

MODERN LABOUR CONDITIONS AS FORESEEN BY A GREAT
PERSONALITY

By James Douglas, LL.D.

In the introductory note to our leading article last month, the significance of the British labour situation was emphasized. It is a revelation of purpose and consequences to be looked for in every other policies in the adjustment of industrial relations.

Dr. Douglas's account of the work of Sir David Dale (for it is a study of the man as revealed by his thought and work, rather than of mere personality) is of much importance because it shows the "far better way" that can be found for reconciling the interests of employer and employee. By revealing clearly the plane from which conditions have fallen since Sir David established harmony in the iron trade in the North of England, a measure is provided wherewith to plot certainly the course upon which the country has been moving, and the end to which it inevitably leads. We hope most earnestly that this patient, intelligent, sympathetic retrospect may help those who are struggling amid the acute problems of the day better to find their position, and mark a safe course out of the present difficulties.—THE EDITORS.

A SHORT memoir of Sir David Dale, which does scant justice to the subject, has recently appeared.* David Dale is worthy of being remembered, outside of the sphere of his many industrial activities, as the most active among the iron-masters of the North of England in promoting and working out to a successful issue the settlement of labor disputes through Boards of Arbitration and Conciliation. Strikes and lockouts were demoralizing all branches of trade in Great Britain during the sixth decade of the last

century. By that time David Dale had risen from being a clerk in the Wear Valley Railway Co., to being the secretary of the short Middleborough & Gainsborough section of the Stockton & Darlington Railroad. His first acquaintance with the iron trade was acquired when he became the partner of Mr. Wm. Bouch in the Shildon Railroad Repair Works. But the opportunity, which his sagacity seized, of displaying his remarkable business talent, was when the Derwent Iron Co. failed in 1858 and he, a young man twenty-nine

* Sir David Dale; inaugural address delivered for the Dale Memorial Trust by the Right Honourable Sir Edward Grey, M.P., to which is prefixed a Memoir by Howard Pease. London; John Murray, Albermarle St., W.

years old, was selected as its inspector. The company had grown too fast on borrowed money, during its seventeen years of inflated prosperity; and when, after its bankruptcy, a syndicate of its old shareholders found themselves unable to meet their obligations and save the property for the original investors, Mr. Dale was the most active and inspiring agent in rescuing the eighteen old furnaces, the rolling mills, collieries, and coke ovens of the Derwent Co. from dispersal, by organizing the Consett Co., to purchase and operate them with sufficient capital and administrative talent. The latter he supplied. The inspector of the old bankrupt concern was made first a director, then managing director of the new company, and finally chairman in 1884. He entered on these onerous duties when the iron trade was on the verge of ruin by reason of strikes, conducted with violence, and by lockouts as re-creminatory measures.

David Dale was a descendent of that David Dale who aided Robert Owen, the embryo socialist, to carry into practice at the New Lanark Mills his social and industrial theories of reform. The instincts inherited by David Dale from his eminent ancestor inclined him to measures of conciliation rather than of resistance.

I first met Mr. Dale when he was a young man, and I was still younger, some sixty years ago. He was then working on a very small salary, and had leisure, which he used in reading *The Times* newspaper as an educational medium, advertisements and all, believing he could better inform himself on all the intricacies of life and trade by studying that daily encyclopædia.

Throughout life he was the very embodiment of accuracy and a man of rigid rules and methods, but of eminent fairness. This was well ex-

pressed in a letter written after his death by Mr. John Wilson, general secretary of the Durham Miners' Association, who had been in many a contest with Sir David:

He was to me one of the sharpest and most intellectual men that ever I met, at the same time being of a most courteous and gentlemanly nature. I have never known him to try to take advantage of any person who might have made a mistake in the use of words. His great object seemed to be to get to know what was their intention and deal with them fairly and honestly.

And Mr. J. Stephen Jeans, in his book on Conciliation and Arbitration in Labor Disputes, explains the anomaly of Mr. Dale—an ironmaster—being again and again selected to fulfil the functions of arbitrator by remarking: "But Mr. Dale's is altogether an exceptional case, as he is also an entirely exceptional man."

Before the date of Mr. Dale's prominence as an iron-master, Mr. Mundella in 1860 had brought harmony into the hosiery and lace trade of Nottingham by introducing a Board of Conciliation; and some five years later Mr. Kettle produced by the same means in Wolverhampton the same happy results. The examples of these two friends and their methods were followed by Mr. Dale when he endeavored to induce the angry iron-workers and the obstinate iron-masters of the North of England to settle their differences by conciliation and arbitration. Conciliatory measures necessarily precede arbitration; but conciliation is often resorted to when the disputants would not bind themselves to arbitration by the decision of an umpire. In the scheme adopted by the iron trade in 1869, arbitration was obligatory if conciliatory means failed.

The first movement was made by

Mr. Dale in 1867, when he moved a resolution at the London Meeting of the Associated Chamber of Commerce in favor of establishing courts of conciliation for the settlement of disputes; but it took two years of patient work to bring masters and men to see the possibility of reconciling their differences by discussion instead of by lockouts and strikes. Moreover, it was more difficult to persuade the operators than the men to resort to reason. The following extracts from Minutes of Meetings of the North of England Iron-Manufacturers' Association will show the stumbling-blocks in the way and the slowness of the progress towards an agreement. Up to that time, of course, the old method of individual bargaining had been in force, and wages were determined by the unsatisfactory processes of higgling and striking.

EXTRACTS FROM MINUTES OF MEETINGS OF NORTH OF ENGLAND IRON MANUFACTURERS' ASSOCIATION

Aug. 8, 1866.

Messrs. Kane & Millington.*

Gentlemen:

I am requested by the Associated Iron Manufacturers of the North of England to acknowledge the receipt of your letters of the 13th and 16th August proposing that the rate of wages to be paid in the mills and forges of this district shall be fixed by arbitration.

I am instructed to inform you that as the present suspension of work arises simply from the masters' inability to continue their works in operation without a reduction in wages, the matter in question is not one which is capable of being adjusted by arbitration.

Your obedient servant,
W. R. INNES HOPKINS,
Hon. Sec.

Dec. 5, 1867.

Mr. Hopkins, having laid before the meeting a proposal from Mr. Kane that a General Conference of masters and men be held,

Resolved, That the Iron Manufacturers of the North of England decline to make any arrangement for meeting their workmen through the intervention of Mr. Kane.

Mr. Dale, however, despite the reluctance of his colleagues in the iron trade, persevered and succeeded by using such arguments as are expressed in a letter to Edward Williams and others:

Darlington, Mar. 25, 1868.

Dear Sir:—

I propose at the ensuing Quarterly Meeting of the Iron Trade to be held at Middlesbro on the 7th April next, inviting the attention of the iron manufacturers of the North of England to the expediency of establishing a Standing Local Committee of Employers and Employed for the consideration from time to time of questions affecting their mutual relations.

The theory of each master bargaining with each man is no doubt a sound one, but when experience has proved the desirability of conducting a business on the principle adopted by Iron Manufacturers, of paying for all the leading branches of work tonnage rates common to the general body of manufacturers within a certain Ironmaking district, such prices being as a general rule varied at all works simultaneously, there comes to be felt the need of some organization enabling the employer to communicate and to discuss matters with the *class* as he would, in the primary condition of things, have done with the individual.

The employed, whose interests are similarly and simultaneously affected by any change in tonnage rates, must naturally be expected to seek some machinery by which their common

* These two men were the representatives of the Ironworkers, and Mr. John Kane was appointed Secretary—as representing the men—to the Board of Arbitration when set up in 1869.

interests can be represented. This, as we know, frequently takes the shape of an Union hostile and distrustful in its attitude towards the Employers and having an executive whose leading men are not themselves affected by the matters which they are called on to deal with on behalf of the general body. This machinery being entirely unsuited to free and friendly communication between the Employers and Employed, each remains in ignorance of the other's feelings and incapable of looking at matters from the other's point of view.

There is a general desire to see a remedy provided for this state of things. The time is favourable. There are no questions now at issue to give any proposal the appearance of being suggested in the interest of any particular party. But this state of things cannot be expected to be permanent. It seems therefore very desirable to be prepared with some organization by which the questions certain before long to arise may be fairly considered and discussed by the two parties interested in their settlement.

Subject to reconsideration and to the suggestions of others, I would propose that such Iron manufacturers in the North of England as may approve the establishing of a "Standing Local Committee of Employers and Employed" should bring the subject under the notice of their Men and invite them to elect two workmen, one from the Forge and the other from the Finishing Mills, to represent their fellow workmen on the Committee. The Firm should nominate two of its principals and the Committee would then be constituted of two Principals and two Workmen from each of the works which come into the arrangement. The primary functions of the Committee would be to consider and discuss *general* questions affecting the *body*.

Its conclusions would have weight as affecting recommendations only,

save where any question between an individual employer and his men might be voluntarily referred by both parties to the Committee.

All questions simply affecting the men at any *one* works would be dealt with (as it is best they should be) by the parties immediately interested, but if they failed to agree, it would be most convenient to be able to consult a body like the Committee, whether the parties agreed to abide by its decision or not.

All *general* questions, however, affecting the relations of the two bodies or any considerable part thereof to each other, would be, as its principal function, considered by the Committee, the views of both parties would be heard, incorrect impressions as to facts (which lie at the root of most trade misunderstandings) would be removed, and in the majority of cases, I am sanguine enough to believe, fair conclusions would be come to by the Committee and acquiesced in by those they represent.

I have thought it best to address you on this subject in anticipation of the quarterly meeting in order that it may in the meanwhile be receiving your consideration.

I should greatly value any suggestion with which you may favor me.

My position as Hon. Sec. of the Iron Manufacturers Association renders it desirable for me to state that this communication must not be regarded as in any way official.

I am, Dear Sir,

Yours faithfully

(Signed) DAVID DALE.

By dint of such reasonable persuasion eighteen out of the twenty-eight iron works in Northumberland, Durham, and the North Riding of Yorkshire and a large majority of the men had been won over by 1869, and had constituted themselves into the "Board of Arbitration, consisting of an equal number of employers and operatives elected by the bodies whom they respectively represent,

such bodies engaging to be bound by the decision of their representatives."

The introduction of the first report states the motives for organizing the association, repeating in part the arguments by which the employers had been converted. It says:

These 28 works employ about 12,000 men and boys. The work is in the main paid for by piece, that is for the various processes of puddling, shingling, heating, rolling, &c., the men receive so much per ton of work done. These piece-work or tonnage prices are, with very slight exceptions, the same at all the establishments in the North of England, and whenever the state of trade justifies an increase or a reduction, such change is made almost simultaneously at the various establishments.

The ironworkers of the North being thus, owing to the character of the business in which they are engaged, dealt with not as individuals, nor even as groups separated into as many bodies as there are employers, but as a *class*, it was natural that some organization should be formed to protect the interests of the body. This took the shape of an Ironworkers' Union. The employers shortly afterwards formed an Ironmanufacturers' Association.

Whatever advantages these bodies may have conferred upon their respective members, they stopped short of bringing together the two classes, of employers on the one hand, and operatives on the other, whose interests had to be reconciled, and whose differences had to be adjusted. If they did not increase, they certainly did not diminish, the feeling of separation and conflict of interest between the two parties, whose agreement was essential to the profitable employment of both.

Referring to a recent lockout and a recent strike, the statement continues:

Their termination settled nothing except that Capital could hold out longer than Labor.

Which party had reason or justice on its side was in no way made apparent by the mode in which the issue was contested. . . .

This state of things led the employers and the more thoughtful operatives, including the Union Executive, to look round for a remedy.

The attention of both parties, acting independently and without communication or concert, seems to have been attracted to the system of Boards of Arbitration and Conciliation established in the hosiery and other trades around Nottingham, and with which, as their chief promoter, the name of Mr. Mundella, M.P., is so justly associated. . . .

The Ironmanufacturers' Association and the Ironworkers' Union having almost simultaneously passed resolutions affirming that this system might with advantage be applied to their trade, a conference of employers and operatives was held on the 1st of March, 1869, and a committee was then appointed to draw up rules. . . .

The employers and operatives of 18 of the 28 works immediately joined the Board and elected representatives.

The Board, on the nomination of the operatives, elected an employer as President, and on the nomination of the employers, an operative as Vice-President.

It unanimously chose as joint-secretaries the Secretary of the Ironmanufacturers' Association and the President of the Ironworkers' Union.

The Board was at once called upon to consider an application from the operatives for a general advance of wages, or tonnage prices for the work done by the piece.

It has investigated the grounds for such an application fully, deliberately, and with a manifest desire on the part of all its members to arrive at an accurate knowledge of the facts.

The organization, recognizing the equal footing on which the operator and operatives stood, consisted of a president and vice-president—one an employer, the other an employee; two secretaries, selected in like manner from the representatives of each class; and a standing committee of ten—five from the men and five from the masters—though these objectionable designations were never used.

The main features of the working scheme were explained in the following extracts from the rules and instructions:

The Board earnestly invites the attention of all who belong to it, either as subscribers or as members, to the following instructions:

If any subscriber to the board desires to have its assistance in redressing any grievance, he must explain the matter to the operative representative of the works at which he is employed. Before doing so he must, however, have done his best to get his grievance righted by seeing his foreman or the manager himself.

If there seems good grounds for complaint, the complainant and the operative representative must take a suitable opportunity of having the matter before the foreman, or works manager, or head of the concern (according to what may be the custom of the particular works). Except in case of emergency, these complaints shall be made only upon one day in each week, the said day and time being fixed by the manager of the works.

The following "Instruction" is illuminating:

The complaint should be stated in a way that implies an expectation that it will be fairly and fully considered, and that what is right will be done.

If however, an agreement cannot

be come to, a statement of the points in difference shall be drawn out, signed by the employer representative and the operative representative, and forwarded to the secretaries of the Board. . . .

Above all, the board would impress upon its subscribers *that there must be no strike or suspension of work*. The main object of the board is to prevent anything of this sort; and if any strike or suspension of work takes place, the Board will refuse to inquire into the matter in dispute till work is resumed, and the fact of its having been interrupted will be taken into account in considering the question at issue.

The intention was, if possible, to compel the men to submit their petty grievances to their representative and allow him, if he regards their complaint as valid, to seek redress from the works representative. The subject was sure to be more calmly considered than if an angry man presented his own case. Moreover, the operators pledged themselves not to suspend work, as well as the men not to strike, without submitting the matter in dispute to the Board.

If the standing committee could not agree, the matter in dispute, whether affecting scale of wages or other important considerations, had to be submitted to an arbitrator.

Between April 20, 1869, and January 26, 1880, there were thirteen arbitrations, all on questions of wages raised in most instances by the employers, who claimed reductions. In two cases the adjustment of the standing scale was in dispute, and both were decided in favour of the men. In three cases reductions asked by the employers were refused. In all other cases either reductions or raises were compromised. The arbitrators were in three cases Judge Kettle, afterwards Sir Rupert; in

three others Tom Hughes, the author of "Tom Brown"; in one Mr. J. Muddella and E. Williams jointly; in another G. Shaw and E. Williams jointly; and in five David Dale.

When in 1881 David Dale was presented by the Board with his portrait in recognition of his services in the cause, Mr. Whitwell, as chairman, gave the following summary of the Board's operations:

For the purpose of arriving at an exact knowledge of the state of trade complete quarterly returns are published by the Board's accountant, Mr. Edwin Waterhouse, of London, which include all the finished iron sold and invoiced by every firm connected with the Board. Although the number of workmen who subscribe to the Board is fewer than it was in 1872, the yearly average number of members has been 10,000 during 12 years, the total income being £15,109, and expenditure £14,019 during that period, or fourteenpence per man annual income and thirteenspence expenditure. The employers give a similar sum, or £630 each side annually, together £1,260. The Chairman concluded by observing that the Board had been the means of settling 700 disputes, and that all joined in contributing to the portrait.

Mr. Dale in his acknowledgment attributed the success of the movement to the loyalty of the Union leaders. He said:

The system has secured peace and regular work; for although there have been from time to time ebullitions of feeling at an award deemed by some of the men whom it affected to be unreasonable, if not unfair; although there have even been loud assertions that an award would not be adopted, and in a few cases actual resistance to its adoption, the loyalty of the general body of men has always shown itself; and, supported by this and by public opinion the

men's leaders have quelled promptly all attempts at repudiation, and have brought into submission those who threatened revolt. Let me, therefore, declare emphatically, as the result of long and varied experience, that the best securities that employers can have for the rule of reason and the observance of engagements on the part of the operatives of any trade is that those operatives should have amongst themselves a union strong in numbers and with an able and thoroughly trusted executive.

Mr. Dale refers in his address to the three methods of determining wages—arbitration, the sliding scale, or mutual arrangement. The sliding scale is virtually a profit-sharing scheme, based upon a minimum wage and a rise and fall in the rate of wages above that minimum with the rise or fall of the price of the commodity made. He says:

To the sliding-scale system of regulating wages I will make only a passing allusion, because it is not a system alternative to or competitive with that of conciliation or arbitration. It is an outcome and development of conciliation, and its bases may be made, and indeed have been made, the subject of arbitration. I would merely remark that the sliding-scale plan can be justified both on theoretical and practical grounds, and that when it is based, as at present, in our northern industries, on results ascertained by independent professional men from employers' books, it secures to the operative class a knowledge absolutely unattainable otherwise of the relative condition of trade at all times. In conclusion, I must confess to feeling anxious on two or three points of primary importance. First, I wish that the tendency should be more towards endeavouring to settle without going to arbitration those larger district questions which require no technical or expert investigation. This would de-

velop the best qualities of candour and moderation on each side, and would diminish the difficulty of finding suitable umpires. To bring this about there must be, as I hope there is, a growing disposition on the part of the operatives to place entire confidence in the fidelity, the watchfulness, the zeal, the discretion, and the ability of their union leaders. Secondly, I feel anxious that a class of men, like our friend Sir Rupert Kettle, fitted by nature and education, and developed by special training, should be rendered available for such arbitration work as would, even under the most complete system of conciliation, still remain to be done.

Mr. Thos. Burt, an old-fashioned union leader moved:

That in the opinion of this meeting the success that has attended the efforts of the Board of Arbitration and Conciliation for the Manufactured Iron Trade of the North of England fully attests the high value of the principle of arbitration, and furnishes to employers of labour and to working men generally sufficient evidence that the establishment of courts of conciliation tends to improve trade and commerce, to promote confidence and trust in others, and above all, to prevent the wilful waste of the accumulated wealth of employers and workmen by strikes and lockouts, which have engendered ill-feeling and distrust where there ought to be mutual confidence and respect.

At a meeting of the Industrial Conference of the Labour Association at Leeds in 1899, Mr. Dale, then Sir David Dale, Baronet, after describing the difficulty he experienced in overcoming the prejudice of the operators against unionism, emphasizes his appreciation of the value of organization on the part of the men, if conducted by able and honest leaders. He says:

This prejudice has been mainly overcome by its being shown that unions have sprung—I believe in most cases—from its being found convenient by the employers to treat the men employed as a class whose wages, hours of labour, and conditions of service, were varied for the class, and not merely for the individual, with varying conditions of trade. This made it not only desirable, but needful, that the workmen should have an organization to consider and determine on their behalf, whether the reduction or advance of wages, or the variation of hours, or the other changes proposed by the employers, were reasonable.

From this tardily conceded admission there is now developing a recognition that not only is a union a reasonable institution, but that it is in large organized trades an essential authority to secure the due observance of wages, compacts or awards, and that hence it is to the interest of the employer that membership of the union should be as wide and general as possible—that all the employed should, by being members, be bound by the agreements come to between the employers and the union. . . .

Although I hold unions to be desirable and needful, and regard their usefulness as proportionate to their numerical strength, I cannot approve of the employer being made to compel men to join. Apart from other objections, it seems to me that it is, from a trades-unionist point of view, unsound and dangerous to treat the employer as having a moral right to say to any of the men employed by him, "You must belong to the union if you continue in my employment." That seems to admit conversely the employers right, if so minded, to say, "You must *not* belong to the union if you continue in my employment." A union that cannot sustain its existence or its influence without resorting to pressure of this sort has some inherent weakness in its constitution or in its management. . . .

We have heard much of the folly, and even of the wickedness, of a great and prolonged strike, entailing privation and suffering—homes stripped of their slowly acquired and much prized household necessities, the cold hearth and the empty cupboard; but is there not another aspect—a certain heroism, which accepts present suffering for future advantage, which renounces that which is easiest, and which might be turned to the advantage of the individual, for the sake of a common cause and the interests of the class. No such self-renunciation as this is, in my experience, exhibited by any other class of the community. With such generally prevailing tendencies to work upon, I regard it as not only unwise and unfair, but unnecessary to apply compulsion to the limited number of men in any trade, who abstain from joining their trades union.

He ended his address with the following gloomy foreboding, only too acutely realized today:

I wish that I could say that when the road of peaceful, industrial arrangement, as described above in its various stages, had once been entered upon, it was never left; but this is not in accordance with observation and experience. There are indications in some of those industries which entered upon that road earliest and have pursued it longest, that a new generation of workmen has not inherited their fathers' experience of how much more may be gained by negotiation or arbitration than by strife or strike. This new generation is showing evidence of a disposition to repudiate engagements, to resist the authority of the union council, to question the genuineness and good faith of prices ascertained by independent accountants, and generally to show itself impatient, unreasonable, and distrustful. This may lead sooner or later to a period of conflict before wise counsels prevail, and before a

new generation has gained its own experience and returned to the condition of disciplined unions and peaceful, though vigilant, modes of securing its interests. For this there will not, I believe, be required anything like the same time and the same amount of education as was needed in earlier generations. The retrograde movement more resembles the receding wave in an advancing tide.

The freedom accorded to English labour to organize, to act on these lines, to have its union funds protected—the recognition which it has gradually secured from employers—the support which is accorded to it by public opinion, so long as it keeps within lines of natural justice, have all tended to avert from England that form of socialism which is occasioning so much anxiety in continental Europe. Every member of the community has an interest in encouraging the English method of evolution, and in affording no justification for the Continental method of revolution.

Sir David Dale was President of the Iron and Steel Institute in 1895-97. The subject of his presidential address was "The Changes Which Have Taken Place in the Iron and Steel Industries Since the Foundation of the Institute in 1869." He could not but refer to the labour question and it must have been with a certain degree of sadness that he anticipated that other motives than mere betterment of the economic standing of the working classes were likely to undo his life work and create strife and confusion. His remarks were as follows:

Men are beginning to ask, with our late president, Mr. Windsor Richards, "Of what use is it to construct labour-saving machinery and so throw more men out of employment, when we have already thousands of willing hands out of work, when every improvement is at once adopted by our

competitors, and every increase of technical knowledge only seems to serve to open out new sources of competition?

The process, however, under the present conditions of trade, seems to be inevitable. The severer the competition, the less can we afford to neglect any means by which excellence of quality and economy of production can be secured. The time seems to have gone by, at any rate for the present, when many investors in manufacturing enterprises can hope to amass the great fortunes which marked the progress of the rapidly developing trade of the country, when we were yet the pioneers of the great mechanical industries, and had the expanding markets of all the world wherefrom to choose.

In view of our enormous actual capacity of production, and the added latent capacity potential in the vast accumulated wealth which is ever waiting to flow into any channel which seems to promise even a moderate percentage of return, competition even within our own borders is practically unlimited. The inevitable logical sequence from this state of things is that our productions will continue to be put upon the market at a price very closely corresponding to the cost. Works will continue to be carried on in the vague hope of "better times," on a basis of selling price which will cover the wages of the workmen and the expenses of management, but with the margin available as dividend for the expectant investor reduced to a vanishing fraction.

This price, too, will be set by the concerns most favourably situated for economy of production, whether by natural advantages of situation, most perfect appliances, or scale of operations.

As in the organic, so in the commercial world, the process of natural selection and the survival of the fittest is ever going on. The individual enjoying an "accident variation" in an advantageous direction will survive,

whilst the weaker will go to the wall. The operation of the inevitable and inexorable law will ever tend to eliminate the less favourably situated, and to concentrate production in the hands of those vast concerns whose resources are such as to enable them to maintain the struggle in exceptionally hard times, as well as to avail themselves of every improvement in processes of manufacture upon the adoption of which their continued existence will depend, and which are denied to their less favourably situated competitors. A concern which finds itself turning out a thousand tons a week at a loss, thinks it sees its way to a profit if it could only double its output, so as to have a wider basis over which to distribute its standing charges—and more capital must be expended, and the capacity of production, already too great, must be added to as a very condition of continued existence. Thus competition is still further increased, and so the race goes on, with less and less prospect of the steady year-by-year margin of profit which was the rule in times gone by.

In ordinary times practically the whole of the proceeds of manufacturing operations tends more and more to go into the pocket of the worker, and very often for long-continued periods these proceeds have themselves to be supplemented out of that of the employer, who can look for anything like an adequate return for his enterprise only in those spurts in trade due to some exceptional temporary conditions, which apparently tend to become both fewer and further between in proportion to the development of the resources of the world and the ever increasing resulting competition.

It may be that at one time manufacturing concerns were carried on too exclusively for the benefit of the capitalist. It would almost seem that at the present day the pendulum had swung to the other extreme, and that the programme of some of our advanced social reformers, that capital

should be employed and works carried on solely for the benefit of the workers, was practically establishing itself as an accomplished fact.

It is a fundamental axiom of the political economist that the price of labour, as of every other merchantable commodity, must be ultimately regulated by the inexorable law of supply and demand. Nevertheless it is equally true that that price may be at any rate temporarily affected and modified by the action of artificial restraints, imposed either by combinations amongst the sellers or by legislative interference. At one time the wages payable to different classes of craftsmen and labourers were directly determined by the state. At the present day an attempt is being made to do the same thing in the form of restriction of hours of labour, the effect of which must be an enhancement of the cost of production, which it is to be feared would often prove fatal to the trades to which these restrictions were applied, by still further handicapping them in the race of competition in which it is already hard enough for them to hold their own.

It is right that labour should receive its fair share of remuneration, and should have a fair day's wages for a fair day's work, and there is probably no one who does not mark with satisfaction the greatly improved standard of comfort which has been attained during living memory among our working population. At the same time every such artificial restraint as has been indicated, by adding to the cost of production, tends to diminish the bulk of trade, and to throw out of employment large bodies of men who otherwise would have no difficulty in ordinary times in securing the means of subsistence.

A labour organization may lay down a rule that no man under its control may work for less than say 36 shillings a week—a not unreasonable income, if the trade will afford it. But suppose that it is found that the result of such a rule is to impose

a cost of production which cannot compete with that which depends upon the cheaper labour of foreign countries, and leads to the closing of work and a large addition to the number of unemployed who are compelled to accept relief work at 10 or 12 shillings a week. The average rate of wages is very soon brought down in spite of the paper law, and the reduced number of those who can still find employment at the trades-union rate of wages are doing so at the cost of their less fortunate brethren, whom the exigencies of mere existence have compelled to work for a miserable pittance in order to keep body and soul together; and thus the average wage is brought down to a figure at which possibly all might have found regular employment.

But of all the mad and fatal expedients for driving away and crippling trade, none are so mad and fatal as the gigantic and prolonged strikes which from time to time disfigure the face of our industrial records, leading in many instances to the closing of works and mines which can never be reopened and the loss of markets which can never be regained.

The Durham Coal Miners' Strike of 1892, the still greater Midland one of 1893, and the Scotch one of 1894, have produced disastrous and far-reaching effects upon national industry, which it is impossible fully to gauge, and the exact number of millions of loss to the country directly and indirectly resulting from these industrial conflicts can never be accurately estimated or fully known.

Perhaps nothing tends more to check enterprise and to alarm capital which might otherwise be embarked in opening out new markets all over the world, than the feeling of insecurity and uncertainty which these conditions of trade produce. Never was there in the history of the world so much accumulated capital waiting for employment; but owing to the unstable conditions of industrial enterprise, capitalists at present prefer securities yielding 2 or 3 per cent, where there is some assurance of sta-

bility, to the more precarious trade investments which have ceased to offer the probability of a return commensurate with the greater risk which they involve.

That the state has a legitimate function to fulfill in fostering by every wise means in its power the trade upon which the existence of the Empire depends, few at the present day would be disposed to deny; but an equally general consensus of opinion on the part of those who are engaged in that trade will probably be found, that State action may be more profitably directed to the opening out by every available means of new and more extended fields of enterprise wherever they can be found throughout the Empire, whether in India, Africa, Australasia, or elsewhere, than in imposing regulations which tend to enhance the cost and restrict the operations of our home industries.

Sir David Dale evidently appreciated that a change was even then coming over the opinions of the working classes; that they were veering towards socialism, and that the influence of the unions would be directed not to the righting of isolated grievances or the fighting for rights under the competitive system, but that their combined forces would be directed towards tearing down the old industrial structure and redistributing property and its management. Ever since the date of his address the steady growth of collectivism has been manifest in the debates and the votes of the Annual Labour Congresses, and in the altered attitude of the representatives of labour in the British Parliament. There is now no disguise as to the views of many of the leaders and as to the methods by which they are determined to carry them into execution. At the opening of the present Parliament the spokesman of the body of Labourites, who are drilled to vote as one man, Mr.

Ramsay McDonald, in the debate on the Speech from the Throne, said:

The workers were asked to trust to Conciliation Boards and Arbitration, but their confidence in their methods had been impaired and they said, "We have been cheated so often, and we are not going to be cheated again." A minimum wage ought to be made the first charge on industry and monopolies ought to be nationalized.

Mr. Robertson, Parliamentary Secretary to the Board of Trade, replied to the criticism against conciliation:

The labor leaders took too pessimistic view of the efficacy of conciliation. It should be borne in mind that the machinery of conciliation was at work all the year around, and that many industrial disputes had been settled without wasteful strikes. By the operation of conciliation leading to rational agreement between masters and men, more could be done to allay unrest than by any scheme for the nationalization of great undertakings. For his part he hoped that conciliation would develop, and that there would be a progressive amelioration in the relations between capital and labor.

So had Sir David hoped; and we all agree in hoping that this happy consummation may come about, but the railroad strike, and the coal strike in Great Britain involving every colliery in the kingdom, are emphatic illustrations of the principles expressed by Mr. McDonald when carried into practice.

When the coal miners refuse to submit the scale of minimum wage determined on by themselves to discussion, they strike the knell—if they can impose their commands on the community—of the old ideas of friendly deliberation upon disputed points between employers and employed, and the substitution of an ul-

timatum which means either submission or war.

The motive of at least a powerful section of the trade unionists of Great Britain today is to use the machinery of organization, not to secure their rights and a fair share of remuneration under the existing industrial system, but to overthrow it entirely and erect in its stead a socialistic community. Under it the State would operate not only public utilities—including railroads and steamboats and illuminating plants, which can be made to pay expenses, just as the most extravagant municipalities can by raising taxes pay their debts—but even such extra-hazardous enterprises as mining, which only in a few instances yield large returns, but are seldom, even if ultimately remunerative, brought up to the paying level without great expense.

Some members of the radical wing of the party issued at Cardiff some time ago a pamphlet entitled "The Miners' Next Step." The proposal it advocated was to create the South Wales Miners' Industrial Organization. The following extracts describe the policy which the organizers have in view:

That the old policy of identity of interest between employers and employed be abolished and a policy of open hostility be installed.

That for the purpose of giving greater strength to lodges they be encouraged to join together to form

joint committees and to hold joint meetings; these committees to have power to initiate and carry out the policy within their own area, unhampered by agent or executive council so long as they act within their own financial resources. The lodges should, as far as possible, discard the old method of coming out on strike for any little minor grievance and adopt the more scientific weapon of the irritation strike by simply remaining at work, and so contrive by their general conduct to make the colliery unremunerative.

That a continual agitation be carried on in favour of increasing the *minimum* wage and lessening the hours of labour until we have extracted the whole of the employers' profits.

That our objective be to build up an organization that will ultimately take over the mining industry and carry it on in the interests of the workers.

However difficult it may be to carry into effect such a radical upheaval of industrial life, it is well to know that such are the ideas which some of the leaders are instilling into the minds and hopes of their adherents. The example of Great Britain illustrates, moreover, the fact that with political power and a distinct workingman's party in the legislature, demands which formerly would have been thrown into the wastebasket, now that they are backed by votes, command the reverent attention of politicians.



THE GIST OF THE SUPREME COURT DECISION IN THE DICK PATENT CASE

By Gilbert H. Montague, of the New York Bar

The importance of the Dick patent case was referred to editorially in our April issue. The refusal of the Supreme Court on April 8 to grant a rehearing has stimulated further the agitation for new Federal legislation, modifying the grant made to patentees under the law as it has always existed. For, as pointed out in our editorial last month, the Supreme Court decision only restated opinions repeatedly handed down in the lower courts, and confirmed the law as it was already clearly understood by well informed lawyers. (See Mr. Edwin J. Prindle's article in *THE ENGINEERING MAGAZINE* for October, 1906.)

Mr. Montague's clear and able digest of the questions at issue should have the most careful attention. For however excellent the motives of those who would reform the law because of this seemingly unsatisfactory result of its operation, amendment without full knowledge of all the consequences might do harm much greater than any it could cure. Most careful deliberative study should mark the procedure. And to this Mr. Montague's argument contributes valuably.—THE EDITORS.

ON March 11, 1911, the United States Supreme Court announced its decision in the case of *Henry vs. A. B. Dick Company*, determining the rights of patent owners under the Federal Constitution and the patent laws. Since the creation of the patent system, following the recommendation of Alexander Hamilton in his Report on Manufactures, and the adoption, in 1790, of the first patent law by the first American Congress, no better considered decision affecting patent rights has ever been rendered in this country.

HOW THE DICK CASE AROSE

This significant decision of the Supreme Court arose out of the following facts:

The Dick Company owned patents covering a mimeograph. It sold to a certain Miss Skou a mimeograph embodying the invention covered by these patents, subject, however, to a license, printed and attached to the machine and reading as follows:

License Restriction

This machine is sold by the A. B. Dick Company with the license restriction that it may be used only with the stencil paper, ink and other supplies made by A. B. Dick Company, Chicago, U. S. A.

Mr. Henry's firm sold to Miss Skou

some ink suitable for use upon this machine, with knowledge of this license restriction under which Miss Skou had bought the machine, and with the expectation that the ink would be used with this mimeograph. The question presented to the Court was:

Did the acts of the Henry firm constitute contributory infringement of the Dick Company's patents?

The Supreme Court decided that these acts constituted contributory infringement.

This decision may best be approached by ascertaining what are the rights of patent owners, what are the rights of users of patented articles, and what are the modes by which patent owners customarily grant to the community the use of their patented articles.

THE RIGHTS THAT BELONG TO PATENT OWNERS

Under Article I., Section 8, Subdivision 8 of the Federal Constitution, Congress has power "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries."

Accordingly, Section 4884 of the

Revised Statutes has been enacted, providing that a patent owner shall have "the exclusive right to make, use and vend the invention or discovery." This "exclusive right" is in effect three "exclusive rights," i. e., the "exclusive right" to make, the "exclusive right" to use, and the "exclusive right" to sell the patented article. The monopoly created by the Federal Constitution and the Revised Statutes is expressly limited to a duration of seventeen years, at the expiration of which the patent owner's rights cease and the public is entitled to the free enjoyment of the invention.

Created by the Federal Constitution, and limited to a duration of only seventeen years, this "exclusive right" is amply justified—to quote Justice Story's famous words—"as a just reward to ingenious men, and as highly beneficial to the public, not only by holding out suitable encouragement to genius, talents and enterprise, but as ultimately securing to the whole community great advantages from the free communication of secrets in processes and machinery which may be most important to all the great interests of society."

For this reason, the Supreme Court, and every other court dealing with patents, has repeatedly held that the patent owner might keep to himself the exclusive use of his invention and neither use it himself nor permit others to use it; and in so doing, he would only exercise the right of any property owner to refrain from using his property or permitting others to use it. Indeed, the courts point out, the public is better secured in respect to the patent owner than in respect to other property owners; because while other property owners may lawfully suppress the use of their property for an indefinite period, the patent owner can suppress his invention only for the life of his patent, and when

the statutory period of seventeen years has expired, the disclosure which he has to make, in order to obtain his patent, will enable the entire community to enjoy, freely and without restriction, the fruit of his genius.

THE RIGHTS OF USERS OF PATENTED ARTICLES

Since the patent owner's "exclusive right" is composed of the "exclusive right" to make, the "exclusive right" to use, and the "exclusive right" to sell the patented invention, the patent owner may, according as he sees fit, dispose of one, or more, or any part of these component "exclusive rights." Thus, when he elects to manufacture the patented article himself, he reserves to himself the "exclusive right" to make, and disposes simply of all or part of the "exclusive rights," to use and to sell the patented article. Again, if he elects not to sell the patented article, but simply to lease it on a royalty basis, he reserves to himself the "exclusive rights" to make and to sell, and disposes simply of the right to use. Similarly, if he elects to dispose of only part of the "exclusive right" to use the patented article, he may reserve to himself the "exclusive rights" to make and to sell the patented article, and also part of the "exclusive right" of use, and may dispose of simply a portion of his "exclusive right" of use, by granting merely a limited right of use—simply, for instance, the right to use the patented article only under such conditions and only with such supplies as the patent owner shall prescribe.

Like the owner of any other property, the patent owner "cannot be compelled to part with his own except on inducements to his liking." Like the owner of unimproved real estate, the patent owner may decline to use his invention, or to allow others to use it. Like real estate owners who

prefer to continue owners, the patent owner may reserve to himself the right of ownership and sale, and, by lease or otherwise, simply dispose of part of the right to use the property. Like every real estate owner that is a landlord, the patent owner may require that his property be used only under certain specified conditions, and for certain specified purposes, and with certain specified accessories. The rights of the patent owner are neither greater nor more unusual than the familiar rights of the real estate owners or other property owners.

Indeed, the patent owner's rights are vastly curtailed, as contrasted with the rights of other property owners, in that the owners of every other form of property may exercise their rights above described for so long a period as they and their successors may desire, while the patent owner may exercise none of his rights beyond the duration of his patent, and at the expiration of the statutory period of seventeen years must relinquish to the public all of his rights.

During the seventeen years that his patent endures, the patent owner may offer to the customer the use of the patented article upon any terms whatsoever, and the customer may take or leave the patented article as he sees fit. If the patented article lack merit, or the price be too high, or the terms or conditions imposed on its use be too onerous, the customer may reject the offer, and turn to a different machine or resort to such appliances as were in vogue before the patented article was invented. When, however, for the purpose of sharing in the benefits covered by the "exclusive right" belonging to the patent owner by virtue of his patent, the customer takes the patented article, upon the express terms and conditions of the "license," under which alone the patent owner

parts with a portion of his "exclusive right" to use the patented article—upon condition, for example, that the patented article shall be used only with certain specified supplies—the rights of the customer to use the patented article are absolutely defined and limited by the terms and conditions of the license under which the patent owner parted with the patented article; in just the same manner that a tenant's rights, in respect to the premises which he occupies under a lease, are limited by the terms and conditions of the lease. The use of the patented article, in any manner except as expressly permitted by the terms of the license, is necessarily a misuse, and an encroachment upon the patent owner's rights, and is an infringement of the patent; just as the use of leased premises, in any manner except as expressly permitted by the terms of the lease, is obviously a misuse, and a breach of the lease, and a violation of the landlord's rights.

When a customer has obtained the use of a patented article, solely upon the condition that he use it in a certain manner, or with certain specified supplies, any use of the patented article, in another and different way, invades that portion of the "exclusive rights" of the patent owner with which the patent owner never parted. The case is precisely similar to that of a tenant, who has obtained the use of a house from his landlord under a lease that restricts the use of the house to a private residence, and thereafter, in violation of the lease, uses the house for business purposes, or for any other use forbidden by the terms of the lease. So long as private property exists, and the commandment "Thou shalt not steal" remains a principle of law and morals, such an infringement of the license will always be unlawful and immoral.

The patent owner cannot ordinarily obtain redress against every user of the patented article who violates the license under which the right of use was granted. The interests of ordinary honesty, therefore, no less than the safety of property and legal rights, require that the patent owner be assisted by law in prosecuting, as "the common source of corrupting influences," such concerns as sell unauthorized supplies to the users of the patented article, with the full knowledge and intention that such supplies will be used in violation of the license, and for the purpose of defrauding the patent owner out of the recompense which the user of the patented article, when he obtained from the patent owner the right to use the patented article by assenting to the conditions of such license, agreed to pay to the patent owner.

THE ECONOMIC BENEFITS OF LICENSE RESTRICTIONS

From the beginning of the patent system, patent owners have been accustomed to realize the value of their patents by granting to others, for an outright price or upon terms of instalment payments, licenses to manufacture, licenses to sell and licenses to use, either together or separately.

Essentially these licenses are all similar. In order to secure one or more of these licenses to exercise one or more, or a part of one of the "exclusive rights" to which the patent owner is entitled, the licensee, in each case, agrees to recompense the patent owner. The only difference is in the mode and terms of recompense.

When the licensee is required to pay a sum in cash outright in order to acquire the right to use the patented article, the patent owner is compensated, without regard to whether or not the licensee exercises the right to use the patented article. When the

licensee is required to pay a fixed sum periodically in the form of rental, the same result follows. In both instances, what the licensee is required to pay bears no direct relation to the amount of benefit which the licensee derives from exercising the right to use the patented article.

To avoid this result, various license plans have been devised, primarily for the benefit of the licensee, under which the recompense that the patent owner receives, in consideration of giving the licensee the right to use the patented article, depends entirely on the amount of benefit which the licensee derives from exercising such right.

The most familiar plan is that under which the licensee pays to the patent owner a royalty in proportion to the output produced by the use of the patented article. Under this plan, the licensee obtains physical possession of the patented article, together with the right to use it upon the conditions of the license, but is not obliged to pay to the patent owner anything for this right of use unless he actually exercises it; and if he uses the patented article at all, he compensates the patent owner strictly in exact proportion to the efficiency of the patented article and to the benefit that he derives from its use.

Under such a license plan, some means must be devised to measure the extent to which the licensee uses the patented article. A frequent measure is the number of articles that the machine produces. When the amount of use or output can be accurately, inexpensively and conveniently measured, either by a register or by an inspection or accounting, this mode of determining the amount of royalty is generally adopted. In the case of innumerable patented articles, however, like the mimeograph in the Dick case, there is no accurate or con-

venient mode of recording the amount of use or output, and inspection or accounting for that purpose would be impracticable and prohibitively costly.

A true measure of the amount of use and output is the material used with the patented article. When, as in the case just described, the amount of this material cannot be accurately, inexpensively or conveniently measured, inspected or accounted for, while it is on the machine, or after it has left the machine, it must be measured before it reaches the machine. By requiring the user of the patented article to obtain such material from a single source, the patent owner ensures the means for accurately, inexpensively and conveniently measuring the amount of the use and output of the patented article and for collecting the royalty so determined, by charging for such supplies a sum sufficient to cover their cost, and also an additional amount in the nature of royalty for the use of the patented article. As regards many patented articles, which otherwise could be sold only in small numbers at a large outright purchase price, no other means of determining a royalty, based upon the amount of use and output, has been found practicable.

The great advantage of this plan to the licensee is that the money burden does not fall upon him all at one time, like the necessity of paying at the outset a large purchase price, but is distributed over a period sufficient to enable him to derive, from the use of the patented article, the means of compensating the patent owner.

Besides these obvious considerations, any one of which alone sufficiently justifies such a license restriction as was presented in the Dick case, there are other considerations which, in a larger view, are even more controlling.

The satisfactory operation of the patented article may, and in many cases demonstrably does, entirely depend upon its use with specially prepared supplies, or in continuity with other specially adapted machines or in some particular manner.

An electrical appliance, adapted for use with a particular kind of battery, might be very effective when so used—in which case its usefulness to the licensee would be considerable, and its commercial value to the patent owner would be correspondingly gratifying; while if used with another kind of battery, it might be ineffective—in which case its usefulness to the licensee would be slight and its commercial value to the patent owner would be disappointing. A license requiring that the appliance be used only with the battery specially adapted to it guarantees the highest degree of usefulness to the user, and assures to the patent owner the commercial value of the patented article to which he is justly entitled.

A patented machine used in manufacture may be contrived with great nicety to take the partly finished product as it leaves another machine, and to continue the process of manufacture for another stage from that point, and then to turn it to another machine, which continues the manufacture from that point. This particular machine, it is obvious, must accurately be adjusted, so as to supplement precisely the work done by the machine that immediately precedes it in the manufacturing process, and to match exactly the requirements of the machine that will immediately take up the work, at the point where it leaves off. The satisfactory operation of the particular machine in question may, and in actual instances frequently does, entirely depend upon the nicety, ac-

curacy, and precision with which it is adapted to the machine that immediately precedes it, and to the machine that immediately follows it, in the manufacturing process. Unless the machine that precedes it is accurately adapted, to bring the half-finished product into just the condition necessary for satisfactory operation upon the particular machine in question, the operation of the latter machine will be unsatisfactory; and the results to the user, and to the owner of the patents covering that particular machine, will be correspondingly disastrous. Similarly, unless the machine that immediately follows in the manufacturing process is precisely adapted to take the half-finished product, in just the condition that it leaves the particular machine in question, it will inadequately supplement the work that has previously been done, and will wholly or in part prevent the successful result, to which the satisfactory operation of this particular machine has fully contributed.

Instances of ingenious and delicate machines, each nicely adapted to perform one stage of a manufacturing process, and together, as an industrial series nicely, accurately and precisely adjusted to take the raw materials through the successive stages of the process of manufacture, until the finished product is eventually turned out, may be found in many highly developed manufacturing industries.

As to any patented article, like the particular types of machines just described, it is obviously proper that the patent owner, in order to insure satisfactory results to the user, and to preserve for himself such commercial value as accrues from the assured satisfactory operation of his machine, may require that the machine be used only with such spe-

cially adapted machines, and in such particular manner, as will insure satisfactory results to the user.

The notion that the patent owner owes the duty to the community of allowing every user of the patented article to experiment with any supplies that the user can find, or to use, in any manner that the user can think of, a patented machine that has been delicately contrived for just one particular use, has no support whatsoever in law or in reason.

Landlords who lease dwellings may provide in the leases that the premises shall be used exclusively for private residences. Apartment-house owners may prescribe in their leases that tenants shall not keep dogs or allow musical instruments or other things that may affect the desirability of other portions of the same premises. Everybody recognizes that landlords and apartment-house owners have a vital interest in the standing, reputation and commercial desirability of their premises, and that they may insist upon such provisions in their leases as shall insure to the tenants themselves, no less than to the owners and to all prospective tenants, the standing, reputation and commercial desirability of the premises. In precisely the same way, patent owners have an interest in the standing, reputation and commercial desirability of their patented articles, and may insist upon such conditions, in respect to their use by their customers, as shall insure to the customers, no less than to the patent owner and to all prospective customers, the standing, reputation and commercial desirability of the patented article.

To suggest that the user of the patented article has some kind of natural right to experiment, as much as he likes, with unauthorized supplies and with forbidden methods

of using the patented article, is as ridiculous as to suggest that a tenant has a God-given right to use his landlord's premises in any manner that violates the conditions of the lease.

THE FUNDAMENTAL LOGIC OF THE DICK DECISION

Briefly, the Supreme Court decided that:

Patent rights are directly derived from the Federal Constitution.

The patentee has the exclusive right to make, sell and use the patented article. Like the owner of any other property, he may sell or dispose of his property upon any reasonable condition.

The patentee may sell or dispose of the patented article on condition that the purchaser use only such accessories as are made by the patentee, provided that at the time the patentee sells the patented article to the purchaser "the purchaser must have notice that he buys with only a qualified right of use."

The public is free to take or refuse the patented article on the terms imposed. If the terms are too onerous the public loses nothing, for it may decline to buy or use the patented article; and when the patent expires the public will be free to use the invention without compensation or restriction.

In affirming these propositions, the Supreme Court stated plain, common business sense, and also long settled principles of law, in reliance upon which enormous business interests have been established. The opinion of the Supreme Court was written by Justice Lurton, who probably has tried more important patent cases than any American judge now living. With him concurred Justice Holmes, Justice Van Devanter, whose experience in patent law while Circuit

Judge was very thorough, and Justice McKenna, who four years ago wrote the opinion of the Supreme Court in one of the most important patent cases of recent years—the Paper Bag case—with which opinion Chief Justice White, then an Associate Justice, entirely agreed. President Taft, when a Circuit Judge, sat with Judge Lurton and repeatedly agreed with Judge Lurton's opinions in patent matters. The majority opinion simply states the law as established by an unbroken line of previous decisions in the United States, in Great Britain, and in every English-speaking jurisdiction. With these decisions Chief Justice White and Judge Taft, as their entire judicial records show, have heretofore been in absolute agreement.

Chief Justice White dissented from the decision of the Supreme Court in the Dick case, and with him concurred Justice Hughes and Justice Lamar. Justice Day did not hear the argument and took no part in the decision of the case. Justice Pitney became a member of the Court after the case was argued, and therefore had no part in the decision. Relying upon all of these grounds, and also upon the important bearing of the decision on prosecutions under the Sherman Anti-Trust Act then pending in the Federal Courts, application for a re-hearing was made by the defendants-appellant, and application for leave to be made a party and for a re-hearing was made by the Attorney-General. Both applications were denied, without opinion, on April 8, 1912. While the rules of the Supreme Court provide that a rehearing will not be granted unless desired by one of the Justices who concurred in the decision, it is not unfair to surmise, in a case of this importance, that this action of

the Supreme Court indicated that a re-hearing by the Court, as now constituted, would not change the decision.

The vehemence of Chief Justice White's dissent from the decision, and his sensational repudiation of the conclusions which the majority of the Supreme Court, trained by years of experience in patent law, held to be supported by logic and by the overwhelming weight of authority in this and every other English speaking country, lends to his dissenting views an interest beyond their intrinsic importance. Fundamentally, they rest upon the assumption that a patent owner "can only keep the article within the control of the patent by retaining the title." Chief Justice White assumes that the patent owner must retain title to the patented article, in order to enforce any license restriction in respect to its use. Obviously, if this assumption be correct, the Dick Company, when it transferred title to Miss Skou, precluded itself from qualifying the transaction by any license restriction designed to prevent the use of the machine except with certain specified supplies, however plainly it might have notified her, at the time that the machine was sold, that it was sold only subject to this license restriction.

The majority of the Supreme Court denies this assumption. Analysing the "exclusive right" belonging to the patent owner into its component "exclusive rights" to make, to use, and to sell, the Court holds that the patent owner, like any other property owner, may sell, together or separately, all, or any, or part of these rights, and what he does not sell remains with him, and does not pass to any one else; and that the mere transfer

of title, or the sale of any other of these rights, does not operate as a transfer or sale of any right or part of any right that the patent owner, by express notice to the customer at the time he parted with the patented article, reserved absolutely to himself and declined to dispose of to the customer.

THE BOGEY OF NON-PATENTED "MONOPOLY"

Chief Justice White's dissenting opinion that the Dick decision tends "to extend the patent so as to cause it to embrace things which it does not include," and permits the patent owner "to extend his patent rights so as to bring within the claim of his patent interests which are not embraced therein, thus virtually legislating by causing the patent laws to cover subjects to which without the exercise of the right of contract they could not reach," is not supported by the facts.

The patent owner profits from his patent only by increasing and continuing the use of the patented article. If he charges an excessive price for the patented article, or for the supplies which he requires to be used with it, if he refuses to furnish such supplies, or if he unfairly discriminates between one user and another in respect to the supplies furnished, the patent owner only retards the use of the patented article and destroys his own property.

Every license restriction, in order to be enforceable, must, as has been shown, be brought home to the customer at the time he acquires the patented article. Unless, at this moment, while the prospective customer, with full knowledge of the license restriction, balancing the advantages and disadvantages which may be obtained from using the patented article sub-

ject to the terms and conditions of the license restriction, completely satisfies himself that the advantages outweigh the disadvantages, he is perfectly free to decline the patented article. If the terms are too onerous, he loses nothing, for he may decline to buy or use the patented article; and when the patent expires he will be absolutely free to use the invention without any compensation or restriction whatsoever.

In 1896, in a decision of the Circuit Court of Appeals for the 6th Circuit, in which Judge Lurton, now Associate Justice of the Supreme Court, who wrote for the Supreme Court the majority opinion in the Dick case, and Judge Taft, now President of the United States, both participated and concurred, the bogey of monopoly in respect to non-patented supplies required by license restrictions, like those above described, was effectually dispelled. The Court showed that this so-called monopoly, far from offending against public policy, was a positive benefit, for the patent owner could accomplish this result only as he could "make and sell an unpatentable product cheaper than any other competitor"; and "the great consuming public would be benefited rather than injured," for this so-called monopoly could endure only so long as the product turned out with the patented invention and these supplies was "supplied at a less price than had prevailed before the invention."

Common sense, no less than the authorities of the innumerable courts that have quoted this decision, supports this reasoning of Judge Lurton and Judge Taft. As a hard-headed Massachusetts judge well expressed it, since the patent owner might stipulate either for an outright price or for a royalty collected out of the profit that he would make in furnishing supplies at an agreed price for

use in the patented machine, "the purchaser, who could not obtain the machine at all, except upon such terms as the owner should choose to impose, might as well agree to pay for it in that way as in any other."

To suggest that such a system tends to create a monopoly in non-patented supplies is absurd. If the patent owner chooses to take his profit in this way, instead of charging a higher price for his patented article, no one is harmed. Granted that he takes to himself a portion of the market for such non-patented supplies. The portion of the market that he so takes is simply the portion that he alone created, by making and selling his own invention. Obviously, had he not made and sold his invention, no one could sell supplies for use in connection with it. By requiring that his own non-patented supplies be used with his own patented invention, the patent owner is taking nothing which in the absence of his patented invention would belong to other manufacturers of such supplies.

The Supreme Court stated the same proposition in the Dick case:

Any one will be as free to make, sell and use like articles [supplies] as they would be without this restriction, save in one particular, namely, they may not be sold to a user of one of the patented machines with the intent that they shall be used in violation of the license. * * *

If he [the patent owner] says "I will sell with the right to use only with other things proper for using with the machines, and I will sell at the actual cost of the machines to me, provided you will agree to use only such articles as are made by me in connection therewith," if he chooses to take his profit in this way, instead of taking it by a higher price for the machines, has he exceeded his exclusive right to make, sell and use his patented machines? The market for the sale of such articles to the users of his machines, which, by such a condition, he takes to himself, was a market which he alone created by the making and selling of a new invention. Had he kept his invention to

himself, no ink could have been sold by others for use upon machines embodying that invention. By selling it subject to the restrictions he took nothing from others and in nowise restricted their legitimate market.

THE GENERAL ACCEPTANCE OF THE PRINCIPLES OF THE DICK DECISION

The decision of the Supreme Court in the Dick case is in line with the whole trend of previous judicial decision in the United States. The same principles have repeatedly been affirmed by the courts of Great Britain, and only last year by a unanimous decision of the Lords of the Judicial Committee of the Privy Council in a decision which determined the law for the entire British Empire.

How completely the English Courts accept the principles of the Dick decision appears from the following language in one of the leading English decisions:

The sale of a patented article carries with it the right to use it in any way that the purchaser chooses to use it, unless he knows of restrictions. Of course, if he knows of restrictions and they are brought to his mind at the time of the sale, he is bound by them. He is bound by them on this principle: The patentee has the sole right of using and selling the articles, and he may prevent anybody from dealing with them at all. Inasmuch as he has the right to prevent people from using them or dealing in them at all, he has the right to do the lesser thing; that is to say, to impose his own conditions. * * * It does not matter what they are, if he says at the time when the purchaser proposes to buy or the person to take a license: 'Mind, I only give you this license on this condition,' and the purchaser is free to take it or leave it, as he likes. If he takes it, he must be bound by the condition. It seems to be common sense, and not to depend upon any patent law or any other particular law.

Nothing in the so-called "Bath Tub case," in which the federal government in 1911 procured an injunction against the so-called "Bath Tub trust," is affected by the Dick decision; for in the "Bath Tub case"

the license restriction was not confined to the use of the patented article—as in the Dick case—but attempted to control the prices and terms of sales to jobbers and wholesalers of articles of general commerce which might be made with the patented article. Such an attempted license restriction obviously exceeded the proper limits above described, and the Court properly held that nothing in the patent law afforded a defense for such an arrangement.

Much has been made, in some quarters, of the fact that in former decisions the Supreme Court has not allowed to copyright owners or to owners of non-patented proprietary medicines the rights which, in the Dick decision, the Supreme Court holds are vested in patent owners. To this objection the Supreme Court conclusively answers that the distinction which it makes between copyright owners and owners of non-patented proprietary medicines, as contrasted with patent owners, is compelled by the express provisions of the Federal Constitution relating to patentable inventions and the Revised Statutes passed in fulfillment of these constitutional provisions.

"It must not be forgotten," says the Supreme Court in the Dick case, "that we are dealing with a constitutional and statutory monopoly." Again, the Court says: "We are not at liberty to say that the constitution has unwisely provided for awarding a monopolistic right to inventors or that Congress has unwisely failed to impose limitations upon inventors' exclusive right of use."

Finally the Court leaves, for the sober judgment of the nation, this solemn warning: "An attack upon rights under a patent because it secures a monopoly to make, to sell and to use, is an attack upon the whole patent system."

COST METHODS THAT GIVE THE EXECUTIVE CONTROL OF HIS BUSINESS

V. LABOR FROM THE COST VIEWPOINT

By Benj. A. Franklin

Mr. Franklin's purpose, as explained in introducing the first paper of the current series, is to exhibit the use and compilation of costs from the standpoint of the executive rather than that of the cost clerk. Beginning with the principles and elements that must be recognized to make a cost statement: a true and instant revelation of actual conditions, he proceeds to the character of the reports that must come periodically to the manager's desk, and then to the methods by which such data can be obtained and assembled. Actual details or devices of cost collecting are discussed only so far as they are important and interesting to the executive. His topics so far have been: "The Philosophy of Costs"; "The Place of the Trial Balance in the Cost System"; "The Cost of the Salable Article"; and "The Economic Consideration of Material by Costs."—THE EDITORS.

ONE of the complaints of labor is that it is viewed too much purely from the cost point of view, yet this is one of the natural outcomes of the struggle for economy and efficiency.

Material, the first element of cost, is an inanimate thing, subject in its use to the intelligence and carefulness of labor.

Expense, the third element of cost, is built up around labor for the purpose of assisting its effectiveness, and guiding it.

Labor is therefore central in the trio of cost elements. It is an element of anxiety to the executive, in that it is the only element of cost whose movement, whose effectiveness, whose control, does not seem to be readily under his will.

But what makes it of the largest interest to the executive is that it is the most elastic of the three elements of cost, and the one whose control permits the greatest economies, increase of volume, and steadiness of operation. For this reason most of the discussed methods of management centre around labor. But equally for the same reason it is important that the executive have definite and close information from his cost system concerning it.

For cost purposes, labor divides itself into two parts; direct labor, or that which can be shown to have a direct relation to a particular article of production, and indirect labor, that which is general to the whole production. This latter becomes, through its indirectness, an element of expense, and ceases to be considered as an element of cost under the caption of labor; although, of course, in the question of economy, it deserves (although it seldom receives) as much attention as does direct labor.

Labor is the simplest of the cost elements in its application and proof as to the total costs. It may be somewhat difficult in certain classes of work to get the time of operatives exactly apportioned to the different articles of manufacture, but it is not difficult to divide all labor, weekly between direct and indirect, and to divide all the direct labor over the total production.

The difficulties of obtaining a proper apportionment of direct labor to units of production are almost entirely human, however. There is a somewhat natural hesitation or antipathy on the part of operatives to having their time on different operations exactly measured, because of the fact that the information will be

used in criticism of them. The inevitability of necessity eventually takes care of this difficulty.

There is considerable hesitation on the part of the executive to supply either apparatus or clerical labor sufficient to get the facts of labor operation, until he has learned from experience that, when the facts are obtained and properly utilized, the expenditure is fully warranted.

There is finally the opposition of the foremen to having their department (to use their own phrase) "turned into book-keeping departments." This opposition, however, can be quickly banished by education, and the application of that element of cost philosophy, co-operation, will readily turn it into enthusiasm for the record in the case of any good foreman.

It will do no harm to repeat here that the best way to gather the facts of any complete costs is to start with the total, and analyze to such details as are desirable, and not to gather minute details with the idea of adding them together to a proved whole.

In the getting of labor costs, therefore, the weekly payroll may be taken as the proved whole and analysis therefrom will give any details desirable.

Now the payroll can be made to tell a good deal more about labor than it usually does. Ordinarily it is used merely for the purpose of paying wages periodically. But important uses can be made of it, both from the point of view of the executive, and of the cost clerk and book-keeper.

Form 11 indicates a method of payroll which offers many advantages, especially for a plant doing its work on order numbers, or in lots. As is apparent from a perusal of this form, the whole story of each department is told—the workmen, their numbers, their rates, what they received,

any deductions, what they earned, whether their work was indirect or direct, if direct, on what jobs, how many hours worked on each job, and what was the cost. This is almost the whole story, and a continuous record made from week to week offers the executive ample opportunity to consider the situation in any department, to consider the relation between direct and indirect labor, to know just who worked on a given job and for how long. It offers the executive the opportunity of a further analysis of his labor, when the labor costs as shown in Executive's order cost Form 3¹ and the costs in Form 4², are not satisfactory, or in sufficient detail to tell the story, just as Form 10³ offers the opportunity to get a further analysis of material. It offers what every cost record should offer, a picture of the situation.

But this payroll offers also to the cost clerk and book-keeper ample information. The payroll of course proves the labor cost as charged to all orders each week. Its weekly totals can be used for cost sheet and book-keeping entries, and, as shown at the bottom of the form they can likewise be used as the bases for adding expense to orders, which items can then be entered in costs and book-keeping at the same time labor is entered. When departmentized, such a payroll, even in a large plant, offers practically no clerical difficulties, but it does offer a proved and complete record and a history, by order numbers, of each man's work—the time notes being the next and final step that can be taken in this analysis of labor.

It does not, however, offer to the executive what he must have in his effort to control labor cost—a detailed criticism of operation time and cost. For it goes without saying that the only manner in which labor can be

WEEKLY PAY ROLL.

Date	Name	No.	Hr. Rate	Paid	Deductions	Remarks	Total Earn'd	Hrs. Wkd.	Indirect Hrs. Amt.	Direct Hrs. Amt.	Order 56 Hrs. Amt.	Order 59 Hrs. Amt.	Order 64 Hrs. Amt.	Order 72 Hrs. Amt.	Etc.
12/23/10	B. Johns'n	1	3.50day	19.00	2.00	Stock.	21.00	6 days	55 21.00						
	J. Smith.	2	.20	11.00			11.00	55	55 11.00						Etc.
	F. Bro	3	.17½	8.25	.50	Insurance.	8.75	50	55 8.75						
	L. Bui	4	.30	13.50	3.00	Purchase.	16.50	55		55 16.50	30	10 3.00	15 4.50		
	E. Jones	5	.30	16.50			16.50	55		55 16.50	30			25 7.50	Etc.
	J. Hanson	6	.25	7.50			7.50	30	2 .50	28 7.00	1½	.37		26½ 6.63	Etc.
	Etc.	7													Etc.
		8													Etc.
		9													
	Etc.			Etc.	Etc.		Etc.		Etc.	Etc.		Etc.	Etc.		
	Totals ...			350.00	15.00		375.00	1500	200 48.00	1300 327.00	61½	18.37	80 20.00	90 22.50	Etc.
	Gen. Expense added			15c	per hour.					195.00		9.22	12.00	13.50	Etc.
	Dept. Expense added			28½c	per hour.					370.50		17.53	22.80	25.65	Etc.
	or expense may be added when desired on % direct labor to expense								% indirect to direct labor ==	14.7					

effectively brought to its best economic state is through the study and control of its least and simplest operations.

Form 12, however, offers a simple and effective means of information on these points, and just as the payroll pictures the situation as a whole, this record pictures the intimate detail of each man's work. Here are seen the date, the man, the machine, the article worked on, the operation, the time and the cost, in comparison with the standard and other records. Here can plainly be observed delays, good records, the results of proper pre-arrangement, the values obtained by incentives, the variations of men and machines. Also, when the work is paid on some of the incentive methods, the earning power of the man on the operation is shown.

In the plant operated under ordinary methods these records are ample, and, for purely cost purposes, complete. With slight variations they may be made to show the facts of the case plainly under any method of labor payment.

The operation of our philosophy of costs is not difficult to construe in respect to these labor records, but a slight recapitulation will show its extreme importance if the executive expects to get results from his labor costs.

In these records practical accuracy is of course assured, since each week, more particularly in the payroll Form 11, a complete division of all labor paid for is made to indirect labor as an expense item, or to some order number.

Imagination and practical instinct, which in service go hand in hand, play a large and efficient part in considering these records. This is necessarily so on account of the elasticity of this element, labor. Without imagination to visualize the events and

conditions pictured by the figures, to gauge the element of human nature, and effects upon it and actions prompted by it, and without practical instinct working to conclusions from this conception, labor costs, offering such large results from their study, are somewhat useless from the point of view of shop control; and it must not be forgotten that costs are more important from the point of shop control than from that of price fixing.

But with these elements, which are really the attributes of a good administrator, in active operation, such a record as Form 12 will unquestionably force the executive to institute some of the modern methods of incentive to labor, in order not only to reduce but to make steady the labor costs and to bring about their approximation to the standard.

In the matter of standards, of course, scientific management has made clear how these may be set with motion and times studies, and it is inconceivable when the possibilities and elasticity of labor are realized that any other standards than these, worked out with a close and careful study of all conditions and necessities, should be considered. But it must not be overlooked that it is futile to work the standard out on one basis and attempt to do the work under other conditions, if it is expected or desired to attain the standards.

Without comparisons, of course, Form 12 becomes useless. There is always in a factory of any size such a multiplicity of labor operations, orders, and labor cost units, that without simple arrangement, the facts of the case (for any purpose of economy or control,) become no better than a series of figures mixed in a lottery wheel. Arrangement is the very life of their use. The execu-

Operation 1.

Operation 2.

Operation 3.

Job done day rate.																		Job done piece work (in red).										Job done day work.									
Date	Machine	Worker	No. Started	No. Finished	Time	Rate, per hour	Cost Unit	Worker Earned	Date	Machine	Worker	No. Started	No. Finished	Time	Rate each	Cost Unit	Worker Earned, per hr.	Date	Machine	Worker	No. Started	No. Finished	Time	Rate, per hour	Cost Unit	Worker Earned	Etc.										
2 12/12	23	13	100	93	8	30c	25.8		2 13	18	15	93	93	3	1 ct.		31	2/14	92	27	93	90	5	30c.	.16%												
2/13			100	96	7½		23.4		2/14			96	96	3			32	2/15			96	96	4¾		14.8												
2/14			100	92	10		32.6		2/19	21	16	92	92	2½			36.8	2/19			92	92	4½		15.3												
2/15			100	98	6		18.4		2/19			98	98	2¾			35.6	2/19	94	9	98	95	6	25c.	15.8	Etc.											
2/17			100	100	5½		16.5		2/19			100	100	2¼			40	2/20			100	98	5½		14												

Job done day rate.

Job done piece work (in red).

Job done day work.

tive must be compelled to scan detail only as it seems desirable.

In any duplication of work prompt periodicity is essential, but in every case, especially in Form 12, the records should be presented in the shortest time after the occurrence so that conditions may be known.

Co-operation of the executive organization becomes in labor costs a large asset. With the multitudinous operations occurring all over the plant, that executive would be, to say the least, very ineffective, who did not see that the records were freely displayed to as many of his staff as have oversight of the work, a controlling mind, or an ingenuity in device, mechanical or human. For, because of the great mass of detail and the large possibilities that lie in labor, of saving and of loss, of energizing or of relaxation, the best results can only be obtained through co-operation of the whole executive organization. Thus the application of the elements of philosophy is especially essential in consideration of this element.

Of course, as is true of any fact shown by costs, the showing of labor from the cost viewpoint can be of value only as it forms the basis for action. Not alone, however, do these labor-cost records have a definite and moral effect on the organization and the operatives, in that, knowing that the times of operation and production are recorded and compared, they will endeavor to make these records speak favorably for themselves; but if they come under the eye of the executive, the variations of the records will force him in the end to seek and maintain modern methods of arrangement, of assistance and incen-

tive to labor in his desire and attempt to study and reduce costs.

An important reason, of course, why it is especially valuable to reduce labor cost is that, since expense cost per unit of production varies with the labor cost on principle, as will be discussed later, when labor cost is reduced in proper ways, expense cost likewise goes down. Thus it is especially important to watch this element, in that its control effects two of the three elements of cost.

But the element of labor is particularly one of which ample, yet simple, records should come before the eyes of the executive and his organization constantly and promptly. Not only because of its elasticity and because of the fluctuation of the element of expense with it, but because it is a human element with a reasoning ability, readily susceptible to the moving power of facts, but very unbelieving of statements made of itself, unbacked by the proof of truth.

The wise executive, anxious for improvement in this most important element, then, makes no mistake in appreciating the necessities and peculiarities of human nature, provides himself freely with the facts, and submits them willingly and confidently to his executive organization. But still further he will make no mistake in taking into his confidence, as far as seems necessary, the actual manufacturers of these records—labor, itself—so that, understanding the reasons and values, and obtaining, under a wise management, a part of the reward, it may produce results not merely worth while, but sometimes unbelievable. But the record is the first necessity.

RELATIVE ECONOMY OF VARIOUS TYPES OF DRAFT EQUIPMENT

By T. F. J. Maguire

FORCED MECHANICAL DRAFT

In preceding articles Mr. Maguire has discussed stack installations for natural draft, and induced mechanical-draft apparatus, the point of view in all cases being the comparative economy of installation and operation under service conditions. A concluding paper will be devoted to the economizer.—THE EDITORS.

INSTEAD of drawing the air through the fuel bed, as in the case with natural draft or with an induced mechanical-draft equipment, there is another common method in use, whereby the air is forced into the ash pit under pressure and escapes through the fuel bed to the furnace. In this system, it is not advisable to have a pressure above the bed of fuel in excess of the atmospheric pressure, otherwise there will be a leakage of the gases from the furnace into the boiler room and constant danger to the fireman, especially with hand-fired furnaces. On account of the impracticability of maintaining an air tight ash pit, there is a limit to the air pressure that can be successfully carried, but this limit is capable of giving satisfactory operation with practically all grades of fuel, with the grate areas that are usually furnished for each particular fuel.

Whatever may be the type of forced-draft equipment, the function of the apparatus is to create sufficient pressure to drive the necessary air through the fuel bed. The draft intensity required to draw the gases through the boilers and breeching is usually created by a stack of the proper height and diameter. In an induced mechanical-draft equipment, the height of stack is determined not by any consideration of draft re-

quired of the stack, but simply by its discharge of gases into the atmosphere at such an altitude as not to make them objectionable. In the forced mechanical-draft equipment, however, the diameter and height of stack are dependent upon the condition of furnishing a certain draft intensity, and this draft intensity created by the stack must be sufficient at all times to pull the gases of combustion through the boilers and breeching.

The forced draft has certain operating disadvantages compared to induced or natural draft. The condition of the fire cannot be watched as closely on account of the necessity (for safety) of cutting off the draft before opening the fire doors; the removal of ashes from the ash pit also requires the forced draft to be cut off, and with forced draft, more ash and dirt are carried away in the gases of combustion and deposited on the heating surface of the boilers. The above disadvantages would particularly apply to flat, hand-fired grates.

The rational field for the forced draft is for underfeed stokers and flat grates, where conditions of operation demand the use of a fuel that requires a high furnace draft and rate of combustion, to obtain the necessary results. Forced draft is commonly obtained by the use of one of

the three following types of equipment:

(1) An ordinary fan or blower operated by a suitable steam engine or electric motor.

(2) A small high-speed fan or blower, driven by a steam turbine on the same shaft.

(3) A steam blower such as the Argand, or as are used for the forced-draft systems for burning low-grade anthracite coals.

BLOWERS FOR FORCED DRAFT

The usual arrangement for a blower system for forced draft is to place the blowers with their driving engines at or near the grade of the boiler-room floor, and in addition to locate them with respect to the ash pits so as to provide the shortest and easiest path for the air from the outlets of the blowers to the ash pits. The duct leading from the blower discharge is carried across the boilers to be supplied, and is provided with branches to the ash pit, each branch being equipped with a damper to regulate the flow of air to each particular boiler. The most approved manner of introducing the air into the ash pit is through the bridge walls, thereby causing the air to blow toward the front of the grates. This arrangement requires the main discharge duct to be carried across the boilers, at the rear of the bridge walls, and in some cases such a location is either not feasible or undesirable. The main duct is therefore sometimes carried in front of boilers and below the grade of the boiler-room floor, with branch connections opening into the ash pits inside of the boiler fronts.

The blowers for this system handle the air supplied to the furnace for combustion purposes, and not the gases given off by the furnace, as is the case with the fans for an induced-draft equipment. Assuming the same air consumption per pound

of coal for the two systems, the weight of gases handled by fans of the induced-draft equipment would be about 6 per cent greater than the forced-draft blowers, and the volume of the gases would be almost twice as great. Evidently the cost of the blowers and engines for a forced-draft equipment would be less than the cost of the fan units for an equivalent induced mechanical draft. The power required to drive the blowers would be less than that consumed by the fans, hence the fuel-cost item chargeable to the equipment would be less for the forced draft than for the induced draft. As the blowers handle only comparatively cool air, while the fans of the induced-draft system handle gases as high as 500 degrees F. or over, the life of the blowers would exceed that of the fans and the blowers would require less care and attention. The stack required for a forced-draft equipment will generally be more costly than the stub required for the induced draft. In boiler plants of two or more boilers, designed to be supplied with draft from a common system, the cost of the breeching, stack, and connections to the fans, stack, and boilers for the induced draft may be considerably less costly than the breeching, stack, and air-supply duct system for the forced-draft system. The relative first cost of the two draft systems will depend, to a considerable extent, upon the local conditions of a plant.

As in the case of the induced mechanical-draft equipment, the selection of a forced-draft fan system will depend upon its relative economy compared to other possible systems and the economy of the blower equipment is vitally affected by the power required to drive the fans. The power required to drive the blowers may be represented by the formula:—

$$P = 0.00032 Qh.$$

in which P is the brake horse power required to drive the blower, Q is the cubic feet of air handled per minute, and h is the pressure developed by the blower in inches of water-column. Assuming an engine friction loss of 10 per cent and a steam consumption for the blower engine of 45 pounds of steam per indicated horse-power hour, the steam consumed by the blower engine per hour (W) is

$$W = 0.016 Qh \text{ pounds}$$

If the coal used evaporates, at actual boiler pressure, E pounds of water per pound of coal, then the steam generated by the boilers per hour (W) is

$$W = 0.25 QE \text{ pounds}$$

and the percentage of the total boiler output used by the blowers (P) is

$$P = 6.4 \frac{h}{E}$$

Comparing this percentage steam consumption with the similar figure for the induced mechanical equipment, it is evident that, under the same conditions of operation, the steam consumed by the forced-draft system will be about one-half of that consumed by the induced-draft equipment. This is so on account of the fact that for the same conditions, the pressure required at the blower outlet is in general less than the pressure required at the inlet of the fan of the induced-draft equipment.

The forced-draft equipment will be applied to the two plants already used for the induced mechanical draft, in order to ascertain the relative economy of the two systems.

Plant No. 1—five 400 horse-power. Water-tube boilers, with 80 square feet of grate area each. Coal, bituminous slack capable of evaporating 7.5 pounds of water from and at 212 degrees F. per pound of dry coal at 50 per cent overload. Draft equipment to

be capable of developing 50 per cent overload on the boilers for considerable periods. Plant operation 10 hours per day, 6 days per week, with average boiler load of 1600 horse power. Cost of coal delivered in front of boilers \$1.50 per ton. Draft equipment required for 20 years. In order to have the same operating reliability as the induced-draft installation, previously figured for this plant, two blower units will be required each capable of handling the maximum boiler horse power. As thicker fires are carried for the forced draft than for the induced draft, a furnace draft of 0.50 inch should be assumed for an overload of 50 per cent on the boilers. Assuming a draft loss of 0.40 inch in duct between blower outlet and ash pit, at this overload, the maximum pressure required of the blower will be equal to 0.90 inch of water column. Each blower will then have to handle a maximum output of 55,200 cubic feet of air per minute, and to develop, at the outlet, at this output a pressure equal to 0.90 inch. Blowers 114 inches in diameter and operating at a maximum speed of 135 r. p. m. (or equivalent) will be required. If the draft losses in boiler and breeching are taken at 0.60 inch as before, the stack required will be 8 feet in diameter and 100 feet in height above the grates. It is estimated that this duplicate force-draft equipment will cost \$2,500. The annual cost of coal per year to operate forced-draft equipment will be about \$240, and allowing \$60 additional for oil, packing, and repairs the total annual cost of material and repairs will be \$300. The forced-draft equipment will have to be duplicated in order to cover an operating period of 20 years, and hence at 5 per cent interest, the annual interest and depreciation charges will amount to \$324. If the same amount of air were required per pound of coal, for both the

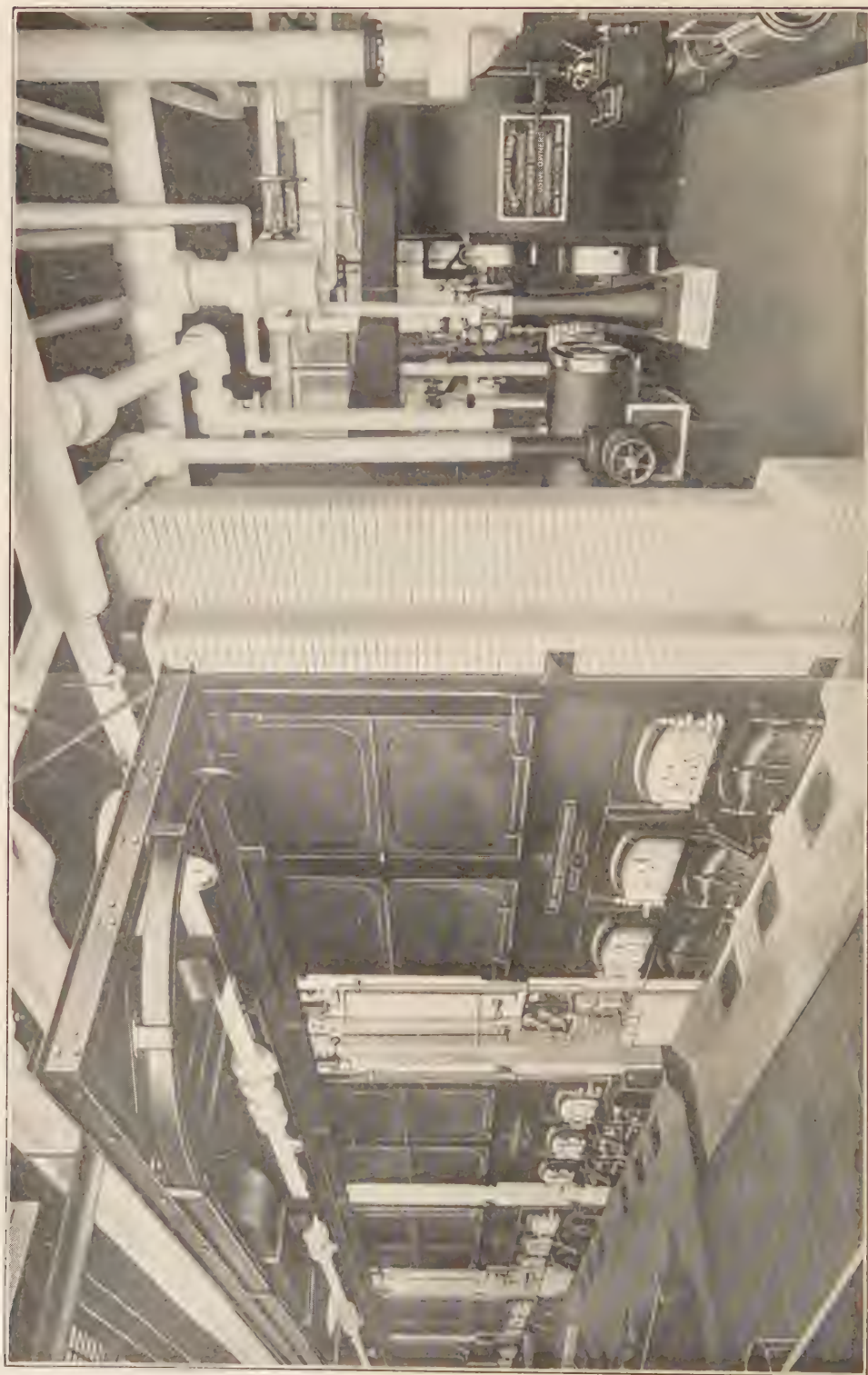
induced and forced-draft systems, the annual cost of the forced-draft system will be \$624, as against \$838 for the induced-draft equipment, or an annual saving of \$214, in favor of the forced-draft equipment.

Plant No. 2; four 250 horse-power water-tube boilers provided with grate areas equal to 1-32 of the heating surface of the boilers. Coal, anthracite buckwheat No. 3, capable of evaporating 7.0 pounds of water from and at 212 degrees F. per pound of dry coal at boiler rating. Draft equipment to be capable of developing 33 1-3 per cent overload on the boilers for considerable periods. Plant operation 10 hours per day, 6 days per week, with average boiler load of 1,200 horse power. Cost of coal delivered in front of boilers, \$1.50 per ton. Draft equipment required for 20 years. Allowing 1.9 inches of draft maximum for the furnace and .40 inch loss in duct between blower and ash pit, at 33 1-3 per cent overload, each blower will have to handle a maximum output of 27,500 cubic feet of air per minute and develop at the outlet, at this output, pressure equal to 2.30 inches of water column. Blowers 64 inches in diameter and operating at a maximum speed of 385 r. p. m. (or equivalent) will be required. If the estimated draft losses in boilers and breeching are taken at 0.50 inch as before, the required stack will be 72 inches in diameter and in height 90 feet above the grates. With the blower equipment in duplicate, it is estimated that the cost of the forced-draft equipment will be \$1,400. The annual cost of coal per year chargeable to the forced-draft system will be \$320; and additional items of oils, packing and repairs, will raise the annual cost of material and repairs up to \$380. The forced-draft equipment will have to be duplicated in order to cover an operating period of 20 years and hence at 5 per cent

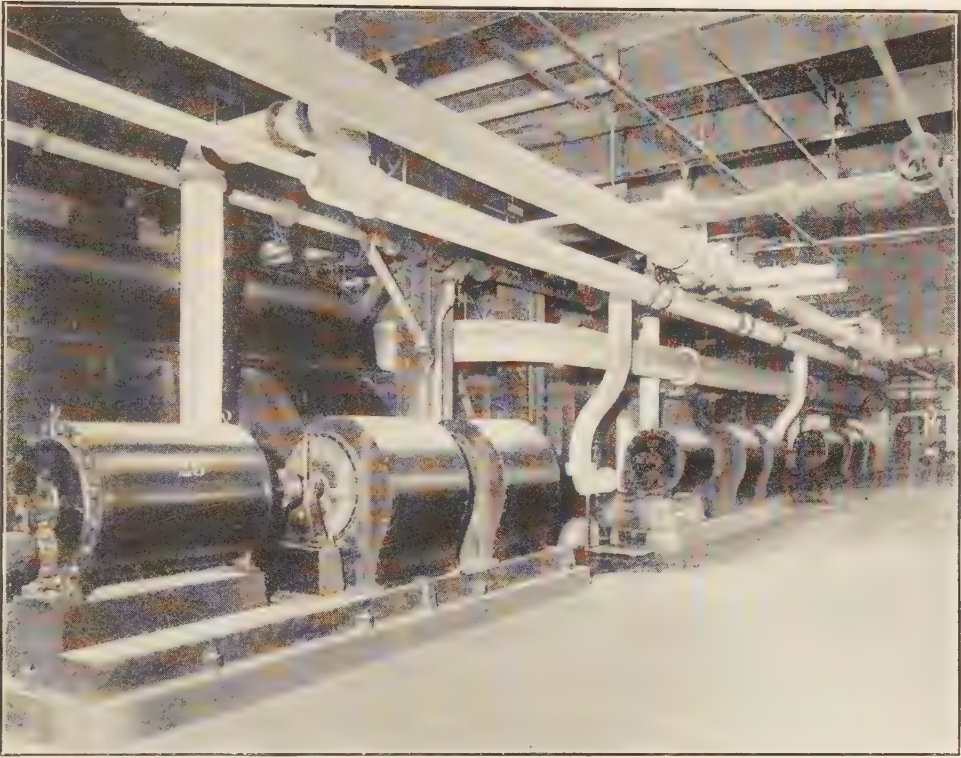
interest, the annual interest and depreciation charges will amount to \$181. If the same amount of air were required per pound of coal for both the induced and forced-draft systems, the annual cost of the forced-draft system will be \$561, as against \$801 for the induced-draft equipment, on an annual saving of \$240 in favor of the forced-draft system.

TURBINE BLOWERS FOR FORCED DRAFT

The usual type of apparatus consists of a special design of disc fan and a steam turbine, the latter consisting of a set of buckets mounted in a suitable ring about the periphery of the fan, and usually three nozzles spaced 120 degrees apart. The steam is supplied to nozzles from a common steam chest and impinges upon the buckets, causing the fan to rotate. The amount of air required for any given condition of operation of the boilers depends upon the speed of the fan, and the latter, in turn, varies with the steam pressure at the nozzles. As the supply of steam to the steam chest is made through one pipe, it is evident that the air supply to the ash pit can be controlled by either a hand valve or an automatically controlled valve in the supply line. It is customary to make the control of the apparatus automatic, so as to maintain a practically constant steam pressure on the boilers at all rates of driving within the capacity of the equipment. For automatic control, the steam supply pipe to the turbine would contain a balanced valve and the motion of the latter would be controlled by an automatic regulator. As the turbine blower simply supplies the necessary draft intensity to overcome the resistance to the passage of the air through the fuel bed, a secondary draft system must be provided to pull the gases through the boilers and breeching. This latter system is usually a stack of the proper height



BALMAIN MECHANICAL-DRAFT PLANT, STEEL BUILDING, NEW YORK CITY
 Steel plates and two vertical exhaust stacks, installed by the American Blower Co.



DOUBLE-INLET SIROCCO FANS, TURBINE-DRIVEN FOR FORCED DRAFT, DETROIT EDISON CO.

and diameter. The stack damper may be readily connected to the automatic regulator provided for the blowers, thereby obtaining the so called "balanced-draft" condition of operation. Of course, with such an arrangement, the connections of the balanced valve and damper to the automatic regulator must be such as to cause the blower to shut down before the damper entirely closes and to start up after the damper has opened.

The turbine-blower system of forced draft requires practically no room in a power plant, and in this respect it has a decided advantage over the induced and forced-draft systems described above. The blowers are installed below the level of the grates, either in the side walls or in the front, and come flush with the exterior surfaces, while the automatic regulator may be placed in any convenient location. The care and attention required for the turbine blow-

ers, as well as the cost of repairs, would be less than for either of the two above described systems. Inasmuch as a turbine-blower equipment is required for each boiler unit, it follows that a breakdown of a turbine blower will throw that particular boiler practically out of service, as the stack alone would not be able to maintain any appreciable load. As it is not customary to install duplicate systems of turbine blowers, it follows that a turbine-blower equipment is not as reliable as the duplicate system of induced draft or ordinary forced-draft equipment. The less the number of boiler units, the greater is the unreliability of the turbine-blower outfit as compared to the two above noted systems.

The comparison of the turbine-blower system with the two previously discussed systems will be made for the two plants noted under those systems.

Plant No. 1. For each boiler of this plant, the turbine-blower equipment will have to provide a maximum air supply of 11,000 cubic feet per minute at a pressure of 0.50 inch of water column. It is estimated that the complete equipment for the five boilers including stack 8 feet in diameter and 100 feet in height above the grates, will cost \$2,500.

As the turbine blowers consume not less than $2\frac{1}{2}$ per cent of the total steam generated by the boilers, the annual cost of coal chargeable to the blowers for this plant would equal \$480. Allowing \$30 per year for repairs, etc., the annual cost of material and repairs would equal \$510. The depreciation and interest charges on the basis of duplicating the equipment in order to run 20 years, at 5 per cent interest, would amount to \$324. The total annual cost of this system would therefore equal \$834, as against \$624 for the duplicate forced-draft system and \$838 for the duplicate induced-draft system.

Plant No. 2. For each boiler of this plant, the turbine-blower equipment will have to provide a maximum air supply of 6,900 cubic feet of air per minute at a pressure of 1.90 inch of water column. Equipment for the four boilers, including a stack 72 inches in diameter and 90 feet in height above the grates, will cost \$1,400. On the basis of a steam consumption of $2\frac{1}{2}$ per cent of the total steam generated, for the turbines, the annual cost of coal chargeable to the turbines will be \$375, or (say) a total annual cost of \$405 for material and repairs. The depreciation and interest charges, on the basis of duplicating the equipment in order to run 20 years, at 5 per cent interest would equal \$181, making a total annual charge against the system of \$586, as against \$561 for the duplicate forced-draft system and \$801 for the duplicate induced-draft.

STEAM BLOWER

There is another system of forced-draft equipment which is in quite common use for the burning of such fuels as the finer grades of anthracite. The equipment consists of a perforated ring enclosed in a funnel shaped tube, located in the side walls or front of the setting, below the grate. The steam issues from the perforated ring in a series of jets, drawing the air through the tube and discharging a mixture of steam and air into the ash pit. The control of this apparatus for automatic regulation of the steam pressure of the boilers would be similar to that already described for the turbine blowers. The steam blower has practically no wearing parts and consequently the repair item for this equipment would be negligible; its first cost would also be less than for any of the draft systems previously described, but the steam required to operate the steam blowers would greatly exceed that required by any of the other systems. The average steam consumption of these blowers may be taken at from 5 to 7 per cent of the total steam generated by the boilers.

Of course the discharge of exhaust steam into the ash pit, for the steam blowers as well as for the turbine blowers considered above, entails a certain loss due to the fact that the steam must be heated from 212 degrees F. to the temperature of the gases discharged from the boilers, but this loss will not be equivalent to more than $\frac{1}{2}$ of one per cent with the equipment using 5 per cent of the total steam generated, and is probably more than offset by the beneficial effort of the steam in tending to prevent the formation of clinkers on the grates. The reliability of the steam blower is the same as given above for the turbine blowers.

The comparison of the steam blow-



A MECHANICAL-DRAFT OUTFIT FOR THE COLUMBUS RAILWAY & LIGHT CO. IN COURSE OF ERECTION
Satisfactory foundations for a chimney were unobtainable, and it was desired to burn the cheapest quality of soft-coal slack, with abundant reserve draft capacity for overloads. Induced-draft plant supplied by Green Fuel Economizer Co.

er with the three forced-draft systems previously discussed will be made for the two plants included in the discussion of these three systems.

Plant No. 1. For each boiler of this plant, the steam-blower equipment will have to provide a maximum air supply of 11,000 cubic feet per minute at a pressure of 0.50 inch of water column. Assuming for the steam blowers a steam consumption of 5 per cent of the boiler output, the annual cost of coal chargeable to the steam blowers will amount to \$960. As the cost of the fuel above exceeds the total annual cost of each of the three other systems, it is evident that the steam blower is not to be compared to the above systems, so far as economy is concerned.

Plant No. 2. For each boiler of this plant, the steam-blower equipment will have to provide a maximum air supply of 6,900 cubic feet per minute at a pressure of 1.90

inches of water column. Assuming a steam consumption of 5 per cent of the boiler output for the steam blowers for this plant, the annual cost of coal chargeable to the steam blowers will amount to \$790. The cost of the fuel above exceeds the total annual cost for the two forced-draft systems noted above, and all but equals the total annual cost of the duplicate induced-draft plant, so it is obvious that the steam blowers for this plant are far from short in economy to the three other mechanical systems.

It must not be inferred from the results obtained above for the two assumed plants that the same results will be obtained in general. The conditions peculiar to each and every plant play such an important part, that it is quite possible that in many cases the relative value of the various types of draft equipment would be materially changed.



NEW FITTING AND ERECTING SHOPS FOR HEATING INSTALLATIONS IN COURSE OF CONSTRUCTION

THE SULZER WORKS AT WINTERTHUR, SWITZERLAND

These illustrations, with a brief synoptical note, are offered for the suggestions they may afford of engineering progress on the Continent, and its significance in present international industrial problems.—
THE EDITORS.

THE Winterthur works date from the beginning of the nineteenth century. Of course, at that time they had not anything like their present importance; the expansion has been gradual; but during the last ten years,

more especially, the business handled in the various departments of the works has increased to such an extent that the establishment may be considered as one of the most important Swiss industrial enterprises.

In 1834 only twenty-four hands



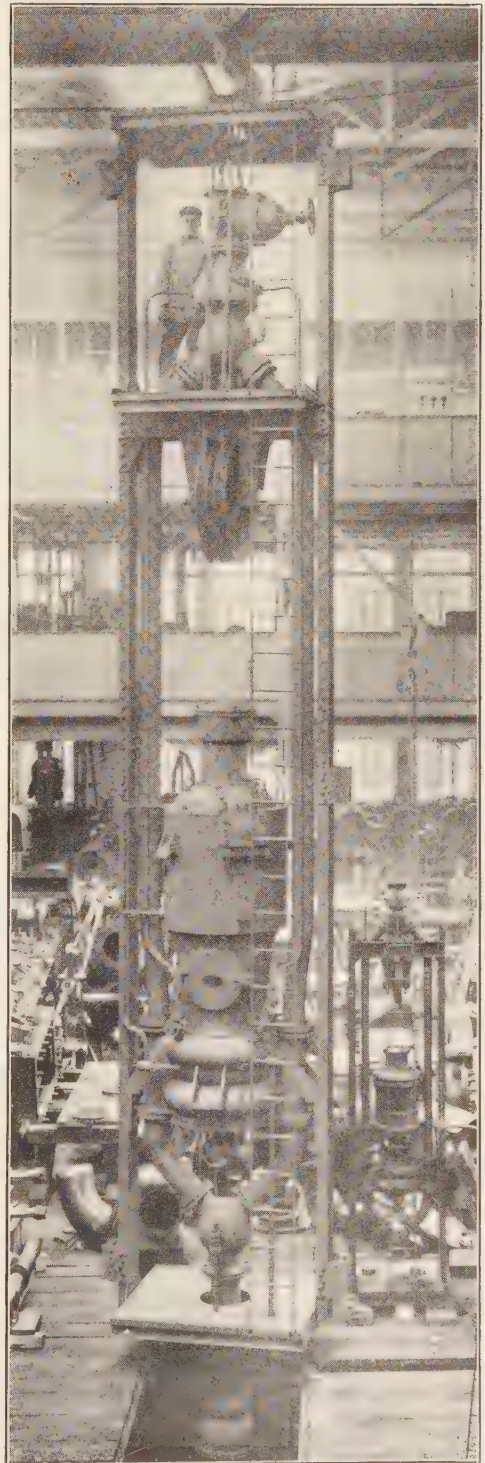
GENERAL VIEW OF THE WORKS

were employed; in 1890, the number of workmen was one thousand eight hundred; now the works give employment to about ten thousand. The total area covered by the buildings of the works is about 110,000 square yards, of which 35,000 square yards are occupied by the foundries, the output of which now amounts to over 22,000 tons of castings. At the Winterthur works, the foundry has always been looked upon as forming the principal shop. The foundries constitute a separate part of the works, and have their own organisation. They employ nearly 1,500 workmen, and castings weighing up to 40 tons may easily be obtained.

At the Winterthur works are manufactured in very large number complete heating plants for dwelling houses and all classes of buildings. The firm has been known for years past most exclusively in connection with the manufacture of steam engines with their special valve distribution, and of boilers. Active development of the Diesel engine is now in progress and the total horse-power of Diesel engines delivered by them up to the present amounts to 145,000. Among the further products of the firm which merit special mention, are centrifugal pumps, ventilating fans, rock-drilling machines, refrigerating machinery, etc. Several large Egyptian irrigation schemes were equipped with pumps by Sulzer Bros. Further, it is interesting to notice that for several years past, the works manufacture shrapnel shell for the Swiss Artillery Corps.

The power stations in the works are three in number, and a fourth station is now in course of erection.

The men employed at the Sulzer works are almost all on piece work. The shop-methods are very generally on the "American system." A special office settles the piece-work



SINKING PUMP IN THE ERECTING SHOP



FOUNDRY FOR HEAVY WORK. RAMMING A MOULD BY COMPRESSED AIR



IN THE BRASS FOUNDRY. LOWER VIEW SHOWS A DRYING STOVE



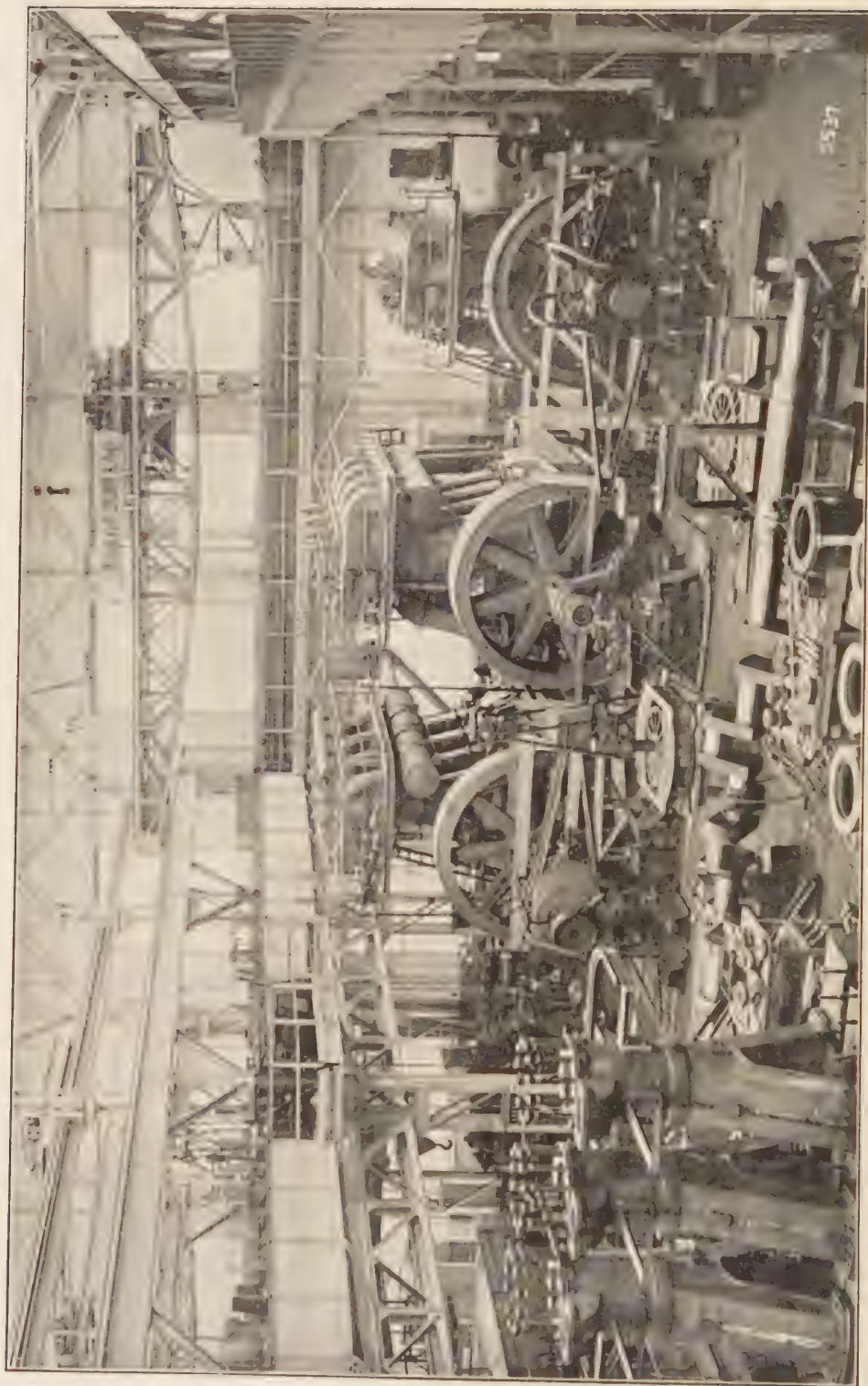
FOUNDRY FOR LIGHT WORK, AND RADIATOR FOUNDRY

prices; the men are satisfied and work with a will. Very complete and accurate account-keeping, which is committed to a separate statistic bureau, makes it possible for the owners and their staff to obtain at any time an exact idea of the progress of the work being carried out in every department. Each machine-tool has its own account, and the work carried out with it is credited to it for

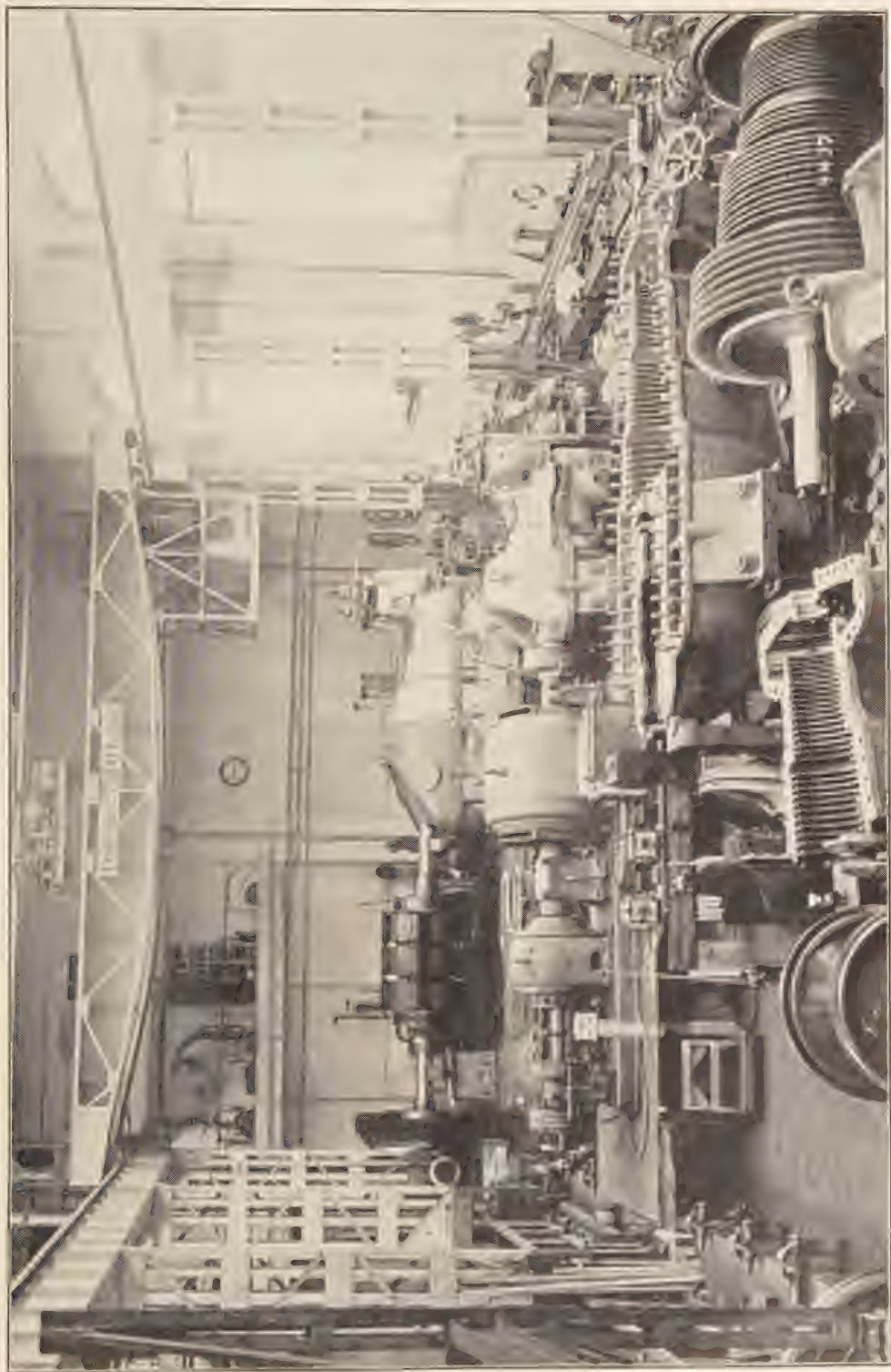
amortisation. A standardising bureau sees that, when this is at all possible, all pieces are manufactured to standards, for which patterns, jigs, etc., are available. This thorough organisation has made it possible for the enterprise to compete with success with the works of other European nations, eminently more favoured from the point of view of physical facilities and raw material,



CUPOLAS IN THE FOUNDRY FOR LIGHT WORK



BAY OF FITTING AND ERECTING SHOP. TWO LARGE TWO-CYCLE DIESEL ENGINES READY FOR TESTING



STEAM-TURBINE ERECTING SHOP A 10,000 HORSE-POWER TURBINE IN THE BACKGROUND

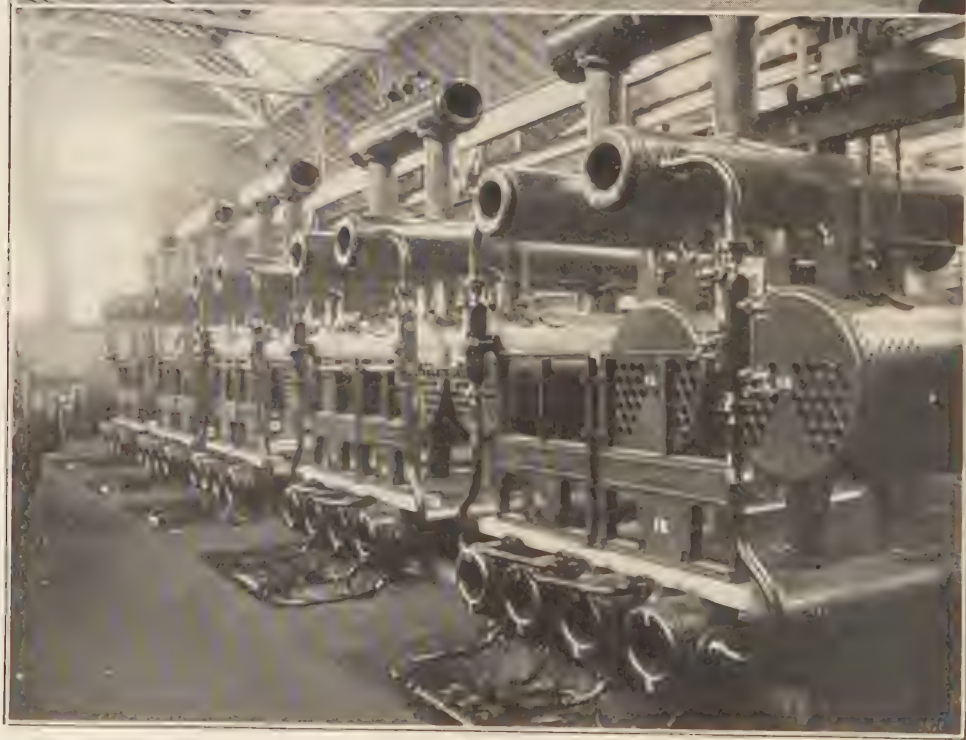
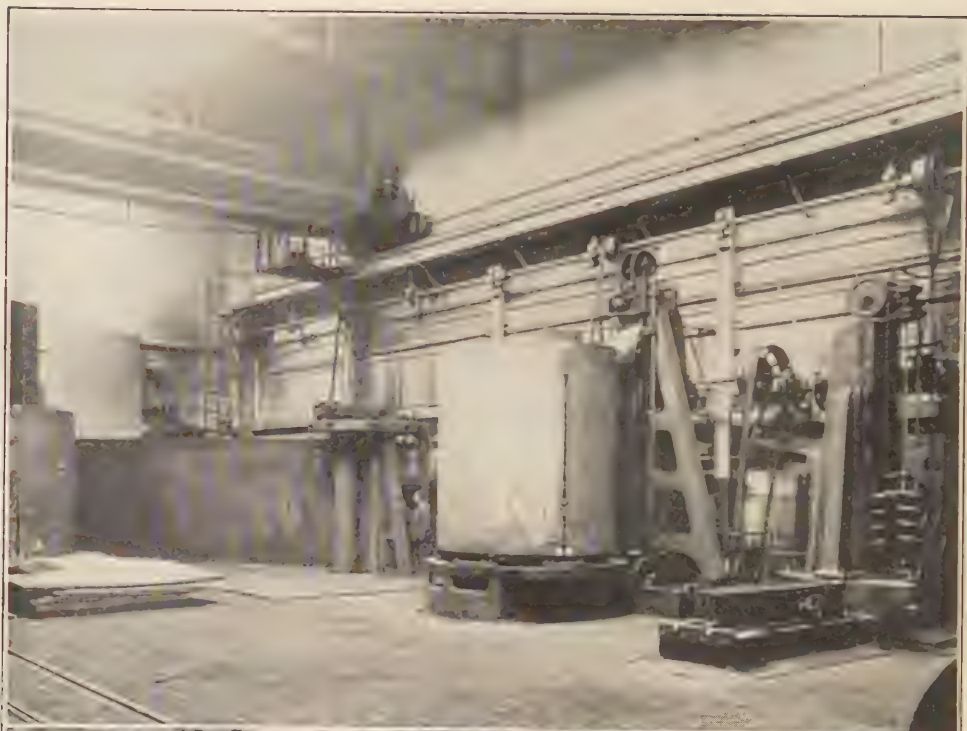
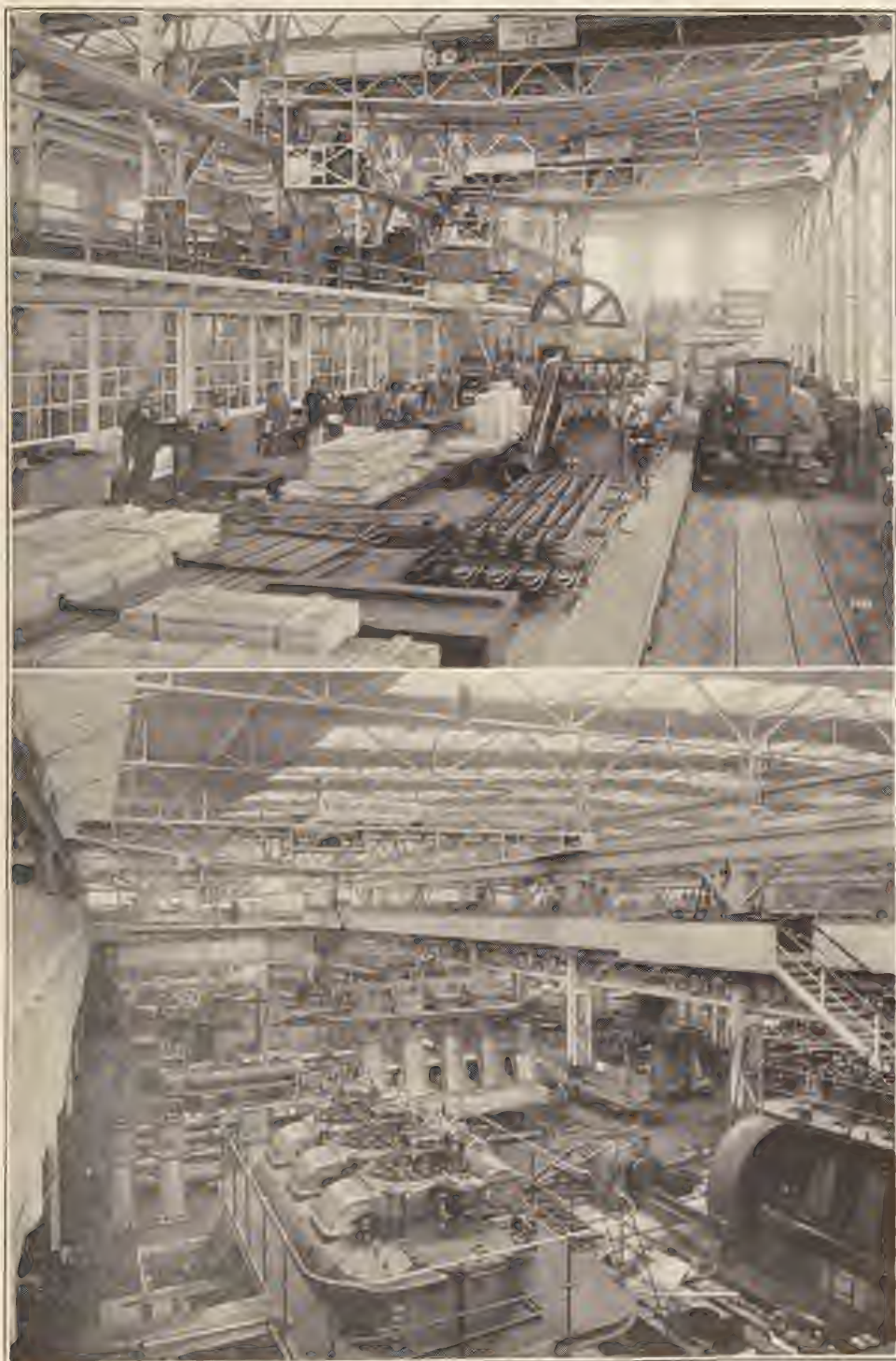
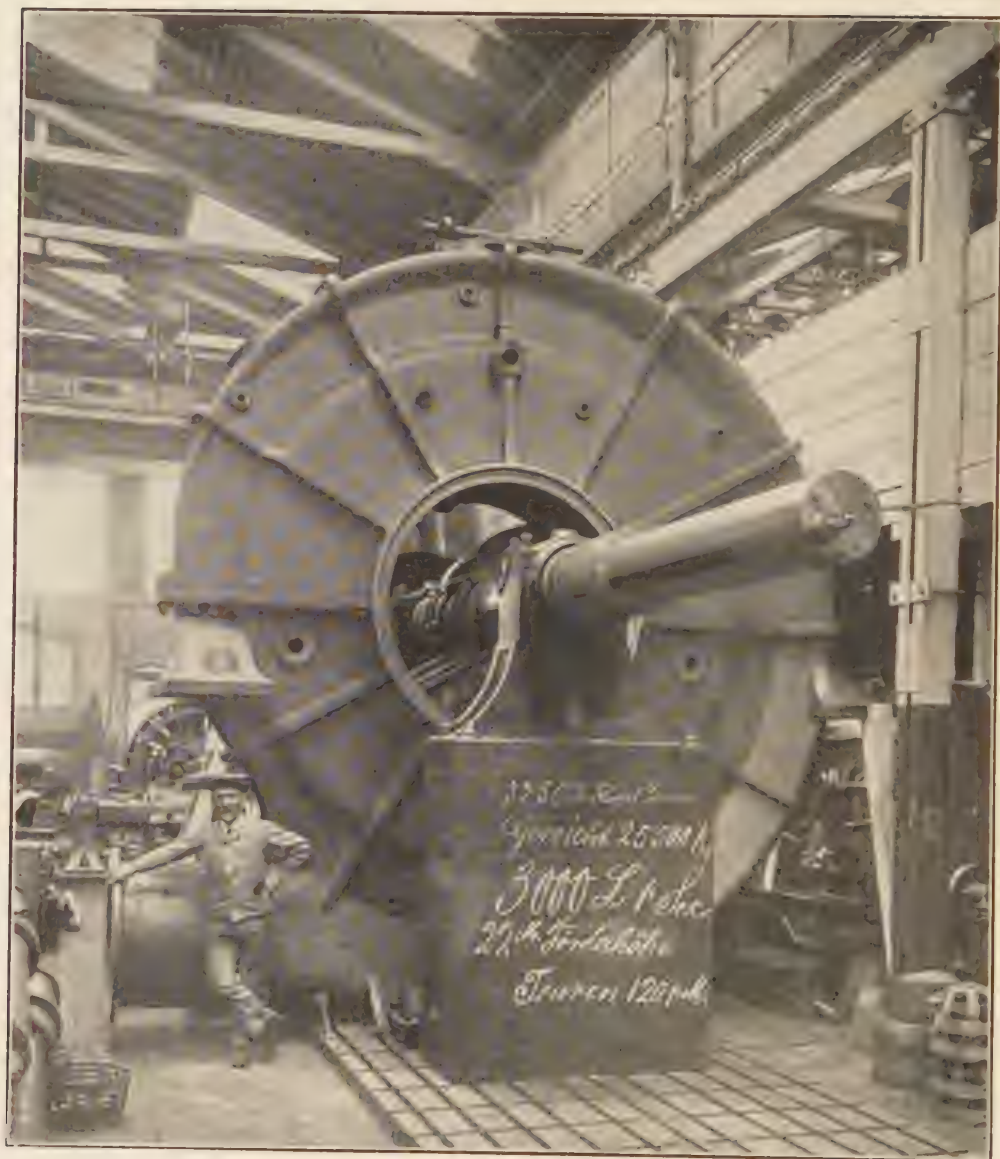


PLATE-BENDING AND MACHINE SHOP, AND BOILERS ERECTED IN BOILER SHOP



DELIVERY BAY, AND FITTING AND ERECTING SHOP FOR DIESEL ENGINES



CENTRIFUGAL PUMPS FOR AN EGYPTIAN INSTALLATION

the totality of which has to be imported from other countries by Swiss manufacturers.

It will be remembered that a particularly active part in the execution

of the Simplon tunnel was taken by Messrs. Sulzer Bros., who carried out a large part of the mechanical and technical work involved in that engineering undertaking.

MODERN ORGANIZATION

V. SUPPLIES AND PURCHASES

By Charles DeLano Hine

Major Hine's most interesting and thought-stimulating statement of a new view of modern organization began in our January issue with an outline of the "unit system" as applied on the Harriman Lines. His second paper, "Broadening the Ideals of Line Supervision," emphasized the reasons for the effectiveness of some of the measures defined in the first. The third installment attacked certain fundamental characteristics of ordinary present-day practice, pointing out that even the cherished institutions of efficiency must be balanced by complementary forces if the true path of progress is to be followed. With increasing definiteness, he then applied this argument to the specific cases of accountancy and permanent special staff, offering a new interpretation of the nature of both functions and new suggestions for their administration to the greatest advantage of total efficiency. The same vision and illumination from a new point of view is now turned upon the purchasing department.—THE EDITORS.

PURCHASING, as carried on by most modern corporations, is an example of exaggerated specialization of function. Purchasing is merely a component of a larger activity, supply. In turn, supply is a part of operation. A failure to appreciate this component relation often results in distorted and unbalanced administration. A strong personality at the head of a purchasing department may unconsciously hamper the efforts of heads of other departments through a failure to appreciate the proportionate value of supply and purchase to operation. Purchasing was originally segregated not necessarily because it was so different from everything else, but rather on account of the volume of the activity having reached a stage where it justified the undivided attention of one person. Such person, being only human, gradually acquired a habit of mind of considering himself as something apart from those less skilled in the technique of bargaining. Where all heads of departments are closely associated in a restricted area, as in that of a single manufacturing plant, daily personal touch is a wholesome antidote for this "we are so different" feeling. The trouble begins when several

plants are associated under a single management more or less remote. It is then that the acute separation of function is defined by thicker and thicker department walls. What was originally a mathematical plane without thickness, becomes first a wall and then a fortification.

Tradition says that in 1861 it was intimated to the veteran, General Winfield Scott, that he who had entered the City of Mexico so successfully in 1847, should have no great difficulty in capturing Richmond. General Scott replied in effect that many of the same able officers who helped him to get into the City of Mexico were engaged in keeping him out of the city of Richmond. So it is in a large corporation. The same people who in the days of small things are engaged in helping the head to enter every possible avenue of composite efficiency, are, as the enterprise grows, more or less unconsciously in rebellion to keep their sometime allies from entering the citadel of what, through segregation, has become a sacred cause. It cannot be repeated too often that the solution of the problem lies in the earliest practicable convergence of complete authority covering the entire activity. No exact solution is possi-

ble because the focal distance of the individuals concerned is too variable. The most hopeful sign of the times is the willingness of the leaders of industrial operation to discuss the subject. Dogmatic generalizations, induced usually from too few particulars, are giving way to a feeling of doubt as to final conclusions. True science, and organization is a science, ever finds its vindication in calm and dispassionate investigation.

An illuminating example of centralized control and decentralized activity is afforded by the purchasing bureaus of the Harriman Lines. The able director of purchases, Mr. W. V. S. Thorne, in New York, makes blanket contracts, when practicable, for such material and supplies as can be most economically purchased *en bloc* for all the railways constituting the Associated Lines. For example, locomotives, cars, steel rails, car wheels, bridges, etc., etc., will usually fall under this class. Each of the constituent properties has its own purchasing agent who, when acquiring standard articles under the blanket contracts mentioned, becomes an ordering agent. On the other hand the purchasing agent of the Union Pacific Railroad of Omaha can probably drive a better bargain locally for such supplies as ties, timber, shovels, brooms, etc., etc. The point of it all is that the policy of centralization is sufficiently elastic to permit discriminating thought by responsible officers. Too much centralization always dwafes the initiative of the man on the ground by inferentially denying him the ability to discriminate. In brief, an attempt is made by primary organization to decide a majority of the questions in advance, a hopeless proposition. It is predicted that the supply and purchase administration of the Harriman Lines will be further decentralized, so that perhaps the division superintendent

can buy to advantage certain of his supplies in local markets or jobbing centres. Most railways and many industrial corporations reason fallaciously that because some things can best be purchased from a centralized office, that all things should be so purchased. The Harriman Lines' reasoning is that experience must be the guide, that some things must be purchased under one method and some under another. Typical of the other view is the Sante Fe System whose officers complain that the allotted three-score years and ten are too brief a span for the countless transitions of requisitions, and supply correspondence, between the great West and distant Chicago.

Could one man do all the buying and insure prompt action and delivery, the segregation of purchasing would be ideal. Soon, however, the purchasing agent gathers around him a large office force entirely unsympathetic with the particular needs of the users of the material and supplies. The office becomes unwieldy and deals with papers and accounts rather than with men and things. The office employee of limited experience may have a greater voice in the management than the experienced officer charged with the largest outside responsibilities. The purchasing agent boasts that his bright assistant saved the company *a* dollars by continued correspondence with certain firms. Meantime the company may have lost *xa* dollars because men were working to poor advantage while awaiting proper tools and material.

Requisitions may be counted a necessary evil to be reduced to the lowest possible terms. Ideal supply would be automatic. Too often a requisition tells a distant officer what it should already know. The largest single item of supply on a railway, fuel for locomotives, is furnished

without regular requisition because the necessities are so apparent. A definite amount of fuel is shipped periodically in the absence of requests for variation in quantity. As administration improves and official ideas broaden, more commodities will be included in the list. A start has been made by numerous railways by running monthly supply cars to issue station and track supplies to agents and section foremen. Most of these roads persist in the foolish practice of sending worthless requisitions with these cars, worthless because the responsible officer with the cars should decide on the ground the amount to be issued in each case. An estimate of the probable total requirements can be made with sufficient practical accuracy for stocking the cars for the trip. Apart from the wasted energy in preparing useless papers, is the psychological effect of causing individuals to give greater weight to the requisition, a shadow, than to the article itself, the substance.

Financiers are learning that there is a practical limit to the amount of work which can be effectively performed by a single office. There was a time when very small railways could be combined in a single working system with unquestioned advantage in administration. Long ago such combination passed the peak of efficiency. A decade ago the promoters of the new Rock Island Railway system acquired the Choctaw, Oklahoma and Gulf, which had its general offices at Little Rock, Arkansas. About the same time they also absorbed the Burlington, Cedar Rapids and Northern, a distinctively Iowa road with general offices at Cedar Rapids. Each of the roads mentioned, with something over a thousand miles of line, enjoyed a considerable degree of local popularity and, therefore, immunity from

drastic legislation. The general officers of these roads had a distinct identity in Arkansas and Oklahoma in one case, and in Iowa in the other. When the citizens of these proud States awoke to the fact that the seats of authority had been removed to far off Chicago, that all purchasing had been centralized in that city, there was a feeling of resentment which necessarily had some bearing in shaping legislation hostile to corporations. To say that ties and timber cut in Arkansas can only be bought to advantage in Chicago is as ridiculous as it is expensive. In sharp contrast to this mistaken policy is the case of the prosperous Louisville and Nashville system, now financially associated with the Atlantic Coast Line. It is an open secret that the Louisville and Nashville controls the Nashville, Chattanooga and St. Louis Railway and the Georgia Railroad; and is a dominant factor in the Atlanta and West Point, which includes the Western Railway of Alabama. Each of the properties mentioned, however, is a distinct local entity with its president and full complement of general officers. It is said that not even are the mechanical appliances standardized as among these different roads. This is perhaps too extreme a condition, but it has at least the value of preventing an undue centralization of supplies and purchases.

The general trend of thought at present is to recognize the sociological element as the most important feature of administration. To offset the local unpopularity of the Southern Pacific in California, some perhaps deserved but much undeserved, a president with large powers has recently been placed in San Francisco. Simultaneously four other presidents were elected for Omaha, Nebraska; Houston, Texas; Tucson, Arizona; and Portland, Oregon. Chairman Lovett has wisely placed upon the

shoulders of these five presidents the duty of acquiring that local human touch which becomes more vital as civilization advances. Chairman Lovett and his five presidents now perform with some degree of comfort the duties which killed that great genius, Edward H. Harriman, who fell a victim to his own juggernaut of centralization.

One of the temptations to which mankind has yielded from the beginning is to seek perpetual motion in administrative, as well as in physical affairs. The hope has been that by some hocus pocus of a constitution, a scheme of government, or a chart of organization, a self-perpetuating entity would be set going to govern internal affairs for an indefinite period. The sociologist sees that systems survive only as they reflect the progress of a people, whether that progress be in government, in administration, or in ability to become self-reliant. A phrase of this general tendency is seen in the segregation of the storekeeping function for large corporations. When irregularities develop, when waste is discovered, when ignorance of materials and their conservation is manifest, the fallacious remedy usually proposed is to place this peculiar activity under the control of a special body of men expert in that one feature. The true function of the specialist and the expert, let it be repeated, is to show the layman how best to perform tasks of a general nature. When a separate department is created such specialization often becomes the lazy man's excuse for side-stepping responsibility. The true solution lies in patient instruction of those who are remiss, in such thorough, broadminded inspection as will insure maximum hearty effort for improvement. Because an artisan is clumsy or ignorant, his superiors should not take away his work-

ing tools until they have exhausted every known method of teaching him the trade or art. The Pennsylvania Railroad, whose organization was laid out by military men a half-century ago, has never yielded to the temptation to create a separate supply department. It has, however, fallen into the mistake of centralizing its purchasing to the extent that a clerk in Philadelphia may discount the judgment of a superintendent in Baltimore or Washington. The Harriman Lines, after various segregations of the supply function, sometimes under the accounting department and sometimes as a separate branch of the operating department, have recently amalgamated supply under Operation by placing all division storekeepers under the respective division superintendents and by including store accounting in the division accounting bureaus. The effect has been to make the superintendent and his various assistants zealous conservers of store supplies, where previously they unconsciously sought to draw the greatest amounts possible from the store because it was in another department for which they had no responsibility. When the bandit really reforms he is an able police chief, a guardian of law and order.

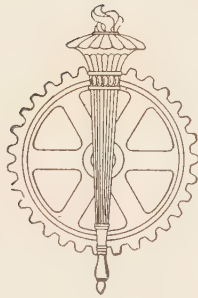
The United States Navy has long had a bureau of supplies and accounts. The members of the pay corps were supposed to be interchangeable as pay officers and storekeepers. This is sound organization and it is to be regretted that a movement is on foot looking to the segregation of supplies from accounts. Both logically and practically the two are closely interwoven. When the volume of business is small the same person can be both pay officer and storekeeper. When warranted by volume the duties can be segregated to advantage, not because of

the inherent importance of either, but solely because there is more work than one man can do. Off-setting this mistaken agitation is the wholesome legislation proposed for amalgamating the pay corps of the Navy with the line. Ultimately, a generation hence, while every seagoing line officer will not be a paymaster, every paymaster will be a seagoing line officer, stripped of that class con-

sciousness which is so fatal to composite efficiency.

Granted the premise that in all organization such ultimate consummation is desired, the conclusion is irresistible that supplies and purchases are but a component of operation whether that operation be the maintenance of a really military navy, the manufacture of steel, or the running of great railroads.

(To be Continued.)



NEED OF RECONCILIATION BETWEEN THE RAILROADS AND THE PUBLIC

By Edward L. Suffern

THERE is no need to use space or words in the endeavor to set forth the tremendously urgent necessity which confronts American railways for the expenditure of very large sums in maintenance and betterments of all kinds. Every official knows it; so does every man who has eyes to see with and brains to think.

With growing population, increasing production and traffic, we are at the threshold of larger demands upon railway facilities than the country has ever seen; at the same time, the railways are in a weaker position than ever before to respond to these demands. What is the reason? There is no one reason, but there is a combination of several reasons, some of which are very obvious and perhaps one or two are not so clear but nevertheless are influential.

It is sure that the railways, like all other forms of industrial activity, have but three methods through which to obtain resources to enable them to carry out any plans of betterment or extension. These three are: first, the earnings from the operations; second, the proceeds of temporary loans; and, third, the increase of capital investment, counting both funded debt and share capital under that head.

It is manifest that under existing conditions the first method offers no hope. Today the railways which can earn enough over costs of operations to care for their fixed charges and a reasonable dividend are in the fortu-

nate class, assuming that the proper ratio of expenditures in maintenance has been maintained. A review of such expenditures as reflected in some recent reports does not encourage us to believe that such ratio has been generally maintained.

The second method is expensive and unsatisfactory and not to be resorted to except as emergency or *ad interim* measures. The frequency with which it has been used of late does not disprove this statement, but rather supports it.

The third method offers the most rational and legitimate means by which resources may be obtained. If capital is to be invested in the development of facilities, it seems most reasonable that it should be obtained through an increase of capital obligations. That is the way it *seems*; but as a matter of fact it *seems* only, rather than is so; for one need not be particularly wise in finance to realize that an offering of new capital shares would meet with very little response, except possibly in the case of a very few of our best systems.

The investing public today is timid about new railway investments, and it is feared it will remain so as long as the present conditions continue, which means just as long as the sentiment of the great public keeps on demanding adverse and repressive legislation and such reduction of rates as to reduce earnings below the point at which investment is profitable. But briefly, it means as long as the general public sentiment

remains opposed to the railways rather than friendly. There is no other influence in our country so powerful as public sentiment, nor is there any other which in the end is supreme.

How can we account for the existence of this adverse sentiment? It would seem as if it should not exist; the railways serve the public and the public supports the railways—not to mention the fact that the public likewise measurably runs them. Between the two parties in interest there should exist only the heartiest accord and co-operation.

In order to understand this unfortunate discord one need only to draw upon his memory and recall the attitude which, only a few years ago, practically all railways assumed towards the public, and which in many instances still remains—that of totally ignoring the public or paying no heed to its requests. Did a shipper protest against rates, he was met with the statement that the rates were fixed and could not be discussed. Did a community ask for better accommodations, it was told that such matters could not be considered. Did an accident occur, the intensely anxious seekers after information concerning the welfare of some loved one were met with the stereotyped reply—"There is no information to give." In a word, the rights, the needs, the anxieties of the public were regarded as purely negligible and not worthy of consideration.

These are fair descriptions of things as they were. Today a more enlightened policy in many respects has been adopted. Meetings of shippers are called. The best talent available to the railways discusses the matter from the companies' standpoint; explains how the rates are calculated, what the service costs and in what manner the service may be improved; and whenever the explanations seem

to show fair and just treatment, they are fairly considered, but what a pity that the same policy was not employed twenty years ago! What bitterness, what intense antagonism might not have been avoided! What radical, unscientific legislation might not have been prevented!

When, a very few years ago, the Union Pacific management adopted the policy in respect to accidents, that all reasonable information should be given out as quickly as possible and that committees should be formed to investigate and declare the causes whenever ascertainable, a long step forward was taken in winning the good will and co-operation of the public. Who can forget, however, the anxious waiting crowds thronging the stations in the large cities beseeching the employees for information concerning some newly reported accident, and meeting with a harshness and indifference which cannot be criticized too severely. Thousands of dollars spent in advertising the attractions and advantages of a Great Scenic, Water Level or Four Track Route could not overcome the bitterness engendered through such experiences.

It is simply incomprehensible that railway managers should maintain such attitudes towards the public upon whose good will and intelligent influence in behalf of the railways the whole future of the latter now rests. There is nothing that the companies can do that is so vastly important as to cultivate a friendly spirit in the public, and to do it quickly. No remedial measures of any kind in legislation or commission rulings will take place unless they are supported and practically dictated by public sentiment.

It is true and very gratifying to note that some officials see this and are doing everything possible to cultivate these friendly relations. The

demonstration trains introduced by some systems whereby great numbers of farmers and shippers are brought into direct relations with the companies' officials and demonstrators, have proved of incalculable advantage. Not only have the farmers learned much of improved methods, but it is safe to say that the indirect gain through the creation of a friendly feeling will be worth ten times the cost to the companies. Every effort of that kind is of immeasurable value. It is a thousand pities that all railways are not managed by equally enlightened and politic officials, men who recognize the fact that the irritation caused by contrary methods does not depend upon the magnitude of the issue but upon the degree of feeling created. A matter of comparatively small moment may be the cause of as much and prolonged bitterness as a matter of five times the consequence. As an illustration, quite recently the citizens of one of the suburban towns in which there are a large number of commuters addressed a courteous letter to the president of the railway upon which the town depended, asking that he name a time to meet a committee appointed by the town to discuss the question of eliminating the grade crossings, the sentiment of the town being in favor of bearing part of the expense. The president sent back word that no meeting need be held, as there was nothing to discuss. Naturally the whole town was aroused and became immediately embittered and proceeded to take up the matter with the Railway Commissioners and have the issue forced. The result is that the railway will have to eliminate crossings entirely at its own expense. The president more recently has asked for a conference with the committee, but it is now too late. Such a meeting would be unproduc-

tive and would probably be only long enough for the committee to indicate the destination towards which the president might travel.

How terribly short-sighted and insane such conduct is! Think of violently antagonizing a whole community through lack of a little courtesy and tact. Twenty Phoebe Snows could not compensate for such a distinct loss.

A recent ruling of the Interstate Commerce Commission against one of our largest systems involved the immense sum of \$3.37. The matter had been for two years in contest resulting from the protest of a shipper that he had been overcharged that amount. It was finally admitted by the company that there had been an overcharge arising through a misprint in its own rates. How many times must \$3.37 be multiplied in order to compute the indirect loss to that company through its persistence in maintaining an unfair contention? Is it possible the officers do not and cannot see this?

It is scarcely necessary to multiply instances. We all know them in plenty, and anyone giving the least thought to the subject recognizes the fact that it is because of the accumulation of individual wrongs—either real or fancied—that the repressive and restrictive legislation has met with such popular support. The railways are engaged in a most important and beneficent work. Without them industrial development and progress would never have attained one-tenth of its present advance, and the people at large know this. They know that every community owes much to its railways; what incenses them is that the railways seem to ignore what they owe to the community.

Assuming that an individual should ride only once in a year, it is reasonable to suppose that at least 30,000,-

000 of people each year come into direct contact with the railways, and upon the impressions thereby created rests the attitude of the individual towards them. What immense possibilities hang upon the attitude they assume! They not only create public opinion; they themselves constitute public opinion—and upon public opinion depends the welfare of any institution which appeals to the public for its support. As an evidence of the value of such support one only need to observe the different attitude of the public towards the management of the "Subway" and the Hudson Tunnels. The enlightened policy of the latter which has manifested itself in its treatment of the passengers is everywhere appreciated and commended. The "step lively" methods of the former engender a constant irritation which affects their really excellent efforts to afford a proper service.

Impossibilities are neither asked nor expected of railway managers. There are many conditions beyond their control, and such conditions the public accepts without complaint; but the annoyances, the many aggravations arising through the enforcement of unnecessary regulations, are a constant source of irritation. Many of the regulations have their origin undoubtedly in the attempt to exercise wise precautions, but they are enforced without discrimination or discernment. Surely it is not necessary that every passenger should have his ticket punched as he passes through the gate. Ninety-five per cent of the passengers are anxious enough to get the right train only and will look out for themselves sufficiently well. The other five per cent can be guided quite as well as now through the gateman calling the train. To demand a ticket—except in rare instances—when to comply a passenger has to drop every-

thing he carries, is a useless annoyance, and the volume of suppressed profanity (and not always suppressed either) it occasions does not assist to an equable frame of mind.

Why should it be that an able-bodied, intelligent person cannot be permitted to accompany an elderly or infirm person to the car, or to meet one at the platform upon arrival? What possible harm can it do, and what an amount of good might it not do? The attendants can surely discriminate in favor of such cases.

Why, if passengers are not allowed to place their hand baggage in the aisles, and that would not be wise, cannot overhead racks be provided of sufficient size to accommodate the articles? Many passenger cars are wholly unprovided, and often where the racks exist they are so small that they serve little purpose. This improvement could be made at comparatively small expense. Has any official thought about it? Tens of thousands of passengers have.

More provoking still are such arrangements as prevent passengers taking a train at stations for points beyond, when the train has to stop anyhow. Why compel travelers to take a local train to a farther station in order to connect with a special train, when the special itself has to stop at the first station in order to change engines? Can anything more arbitrary or unreasonable be devised?

On one of the roads accommodating thousands of commuters there exists what appears a most senseless and unquestionably exasperating regulation. A short distance out is a junction point where the main line and a short branch unite. A ticket bought to the first station on the branch is good to the first station beyond the junction on the main line and *vice versa*, the local fare to either station from the junction being five cents;

but a ticket good to the second station on the main line (or the branch) is not good for use to the first station on the branch, although such a ticket costs ten cents. That is, the company will not accept a ten-cent ticket for a five-cent ride. Inasmuch as the locality is thickly settled and the distance between the main line and the branch is small at these points, the convenience of probably ten-thousand passengers is disregarded through a most arbitrary regulation, which has not the plea of expense to support it. One passenger who was refused a five-cent ride on a ten-cent ticket not long ago was so incensed that he looked around to observe some technical violation of the law on the part of the road; finding one, he reported it to the Commission, who ordered the road to comply at an expense to it of probably several thousand dollars. The company, of course, never knew why the Commission should suddenly make its ruling, but this was the reason. The passenger in question feels that he has got even with the road, but he is still just as mad.

In a very recent issue of *Harper's Weekly* is an article referring to the manner in which so many trains are abruptly started and stopped, and commenting upon the effect of such joltings on the passengers. The article states that it sent a clipping of a passenger's letter on the subject to the general passenger agents of six different roads running out of New York. This was on November 28 last. On December 14 one of the general passenger agents replied reciting a

story, the gist of which was that the man who told it lied, and implying of course that the complaint voiced by *Harper's Weekly* was based upon a lie also. The journal remarks that it is difficult to understand why a courteous letter addressed to the officials of six roads should meet with only one reply and that one be so discourteous. It is difficult indeed—or it would be if we were not so used to it—but can obtuseness and imbecility go further? Probably 30,000 people have read the article, every one of whom has agreed with it and felt irritated against the officials.

A great popularity awaits the management which shall study the needs of the public in an earnest endeavor to formulate methods and regulations that shall provide for the largest measure of public convenience and freedom from unnecessary restrictions. Such a policy would do more to win the patronage of shippers and passengers than any amount of advertising. The very novelty of it would win. The railroads should spend \$300,000,000 at once in bringing up their maintenance to standard and in betterments. Where are they going to get it?

Let the railway officials, every one of them from the highest to the lowest, realize that their greatest asset is the good will of the public. Let them understand that their nearest and highest duty is to secure this good will and to make it active in their behalf, and they will be doing more for their own benefit than anything else they can undertake.



RATES FOR ELECTRICITY

By R. L. Ellis

Few questions are more active today than that of fixing a just basis of rates and revenue for public-service corporations. Mr. Ellis considers the subject from the well informed viewpoint of the practical operating official of an electric-lighting company.—THE EDITORS.

A CAREFUL inspection of the rate schedules of the various plants furnishing electricity throughout this and other countries reveals a very great diversity of methods of charging. This is probably more strongly marked in this industry than in any other field of endeavor. And since the costs involved in operating these plants follow the same general characteristic lines, it is evident that a great number of these rate schedules either have been made in ignorance of the basic principles governing the costs; or the element of chance has had too large an influence; or else there has been some local influence which could not be ignored which has had a large effect in the actual schedules adopted. Indeed, in making up a schedule of rates for any particular plant or locality, it is generally much easier to figure out the cost and a system of charges as they should be (judged from the standpoint of the plant furnishing the service) than it is to fit these same charges to the locality served and make them apply practically. In any successful system of rates there must be a nice adjustment to the particular locality served, and there is frequently a political aspect to the question that insists on being considered. And it sometimes happens that the latter fact has a larger bearing on the actual rates selected than all other considerations combined.

Any intelligently devised schedule

of rates must take into consideration one other very important factor—the law of supply and demand. In few, if in any, discussions of the rate question that have come before me has this point been dwelt upon; just why, it is difficult to understand; since, like any other service or commodity (if you will), electricity is worth just what the traffic will stand. Only it should be borne in mind that since the company supplying electricity is under certain legal restrictions due to the nature of the business, an extortionate rate is not justified even though the user cannot choose but pay.

Then, too, it should be remembered that the volume of output in any given plant is to a large extent dependent upon the rate charged. Mr. W. D. Marks has even reduced this relationship to a definite law, using the gross income of the various Massachusetts companies as a basis. This law, he asserts, plotted with gross sales per capita as ordinates, on a base of price per kilowatt-hour, rudely approximates a rectangular hyperbola referred to its asymptotes. While it is very doubtful if this law will hold strictly, it is certainly true that for reasonably large communities, increased consumption responds very quickly to a decrease in rates. The smaller the community served, of course, the less the increase in consumption with reduction in rate.

The above being so self-evident, it will be apparent that it will be im-

practicable not to say impossible, to devise a schedule of rates that will be universally applicable. This is true, not only with reference to the actual rates adopted, or amounts charged per unit of service rendered or per unit of energy supplied, but also to a less degree to the method of assessing these charges as between different consumers served. I believe, however, that it should be possible to lay down certain principles underlying the determining of the basic costs and the apportioning of them, and to develop a general scheme of rates which as a basis can be modified to suit the local conditions.

It is therefore the purpose of this paper to endeavor to deduce a basis for making rates which shall as nearly as possible suit the average conditions surrounding the supplying of electricity, which basis can then be modified to suit a given plant.

There are, then, certain elements that must be inherent in any successful system of rates, these elements being so self-evident that they need not be more than mentioned. The rates should be such as to return to the company a reasonable profit. They should be just and fair as between the consumer and company serving him, and as between different consumers and different classes of consumers. They should be so devised as to attract the largest amount of profitable business. They should be simple and easily explained to the average consumer, and easy to handle by the accounting department. They must be what a writer on gas rates term "sociologically expedient"—that is, must be nicely adjusted to the public actually dealt with. This is quite an array of conditions to be more or less perfectly met, but all very important, and few capable of exact mathematical determination. Any rate schedule then, must represent a series of compromises.

In devising a rate sheet it may be well to look more or less closely into the methods so far used commercially and the conditions surrounding their use, and see how well they have met the conditions. The rates that have had any considerable use have been: the flat rate per light installed, either with or without a differential based upon the number installed; flat kilowatt-hour rate with or without differential based upon the total consumption; differential rate based upon the time of day service is used; and differential rate based upon the number of hours per day that the maximum demand is used, or the so-called Hopkinson principle.

The flat rate per lamp or opening was the first method of charging, and was adopted largely for the reason that there was no other method of measuring the service rendered. Moreover, in the early days of the electrical business, the plants were small and the consumers not widely scattered, so that it was not a very difficult matter to keep track of the consumers and their load conditions rather intimately. Add to this the fact that most of the plants were run for only a small portion of the day, and it is evident that it was a comparatively easy matter to determine with considerable accuracy the amount of service rendered the different consumers. Under these conditions the flat rate was rather satisfactory. And while that fact had small, if any, bearing in the making of these rates, the flat rate was preferable to a flat kilowatt-hour rate under the then conditions, because of the fact that the fixed costs of operation are usually predominant.

Had there been devised some method of limiting the time during which the service could be used, or the maximum load that could be thrown upon the station, it is probable that the flat rate would have continued in consid-

erable popularity after its supposed usefulness was at an end. And as a matter of fact, this same flat rate has shown a wonderful vitality since in few rate schedules is it entirely ignored, and with proper safeguards it is capable of producing considerable profitable revenue for a long time to come.

When, however, the plants began to increase in size and to render a twenty-four hour per day service, the flat rate become inadequate to cope with the situation, largely because there was no incentive for a consumer to economize in the use of his service, and it was not infrequently the case that the whole load would be left on the system for the whole twenty-four hours, whereas the rate was based upon much shorter use. The limitations of the flat rate, *per se*, are so evident that they need hardly be elaborated.

These limitations brought out the early meters for measuring the service rendered. The first meters, I believe, were ampere-hours meters, and later the watt-hour meter was developed and a straight or uniform kilowatt-hour rate was inaugurated; and with the addition of a discount, depending upon the amount of electricity used, this rate is still in considerable use. There has been proposed, I believe, and used to a very limited extent, a differential rate based upon the time of day at which the service is in use. This necessitates, for practical application, the use of a meter with two recording trains and a clockwork mechanism to shift from one to the other, which is very much against the system on account of the cost and complication of the meter.

These rates were in large measure patterned after the rates in vogue for water and gas, and do not take into consideration the fundamental differences between the supply of

electricity, on the one hand, and the supply of water and gas on the other. Unlike water and gas, electricity can be stored to a very limited extent and at relatively very great cost. It must be delivered at the very instant made, and the consumer will not wait for his supply but wants it ready for his instant use, day or night. If the plant supplying him fails to have the supply at his instant disposal it is a reflection on the service. Obviously, then, the size or capacity of a consumer's installation determines the amount of electricity that he can possibly require at any one time, and the size of the plant determines the maximum amount that it can supply at any one time.

Further than this, most of the consumers using light will want to use it at substantially the same time, and will use it to a larger extent during the short days of winter than at other times during the year. On the other hand a consumer may have a large installation of lights and use them only a very small number of times during the year, and a power consumer will use his power only as his needs dictate and generally not to the full capacity of his installation.

A plant supplying electricity must be prepared to make and deliver sufficient electricity to take care of the aggregate requirements of all consumers who will use their loads simultaneously. Or to state the matter a little differently, it must be able to take care of the "peak of the load," though obviously this need not be the total amount that the aggregate of all of the consumers might possibly use at any one time. Experience with a particular plant indicates the capacity necessary to take care of the peak load properly. The relations of the peak load to the aggregate of the consumers load in no two plants are necessarily the same. It may be said,

then, that the investment for generating machinery is determined, in any given plant, by the greatest demand upon the station at any one time, irrespective of the length of time during which this demand may be used.

These fundamental differences seem first to have been recognized by Dr. John Hopkinson, and were enunciated by him in his classical paper before the Junior Engineering Society of London in 1892. In this paper he laid down once for all the principles underlying the determining of the costs for electricity supply. This gave rise to a method of charging based upon costs, and being based upon principles formulated by him was called Hopkinson method. This was amplified and energetically advocated by Mr. Arthur Wright in what became the Hopkinson-Wright system of charging, sometimes referred to as the Wright Demand system. In this latter it is usual to use the demand indicator devised by Mr. Wright.

All of these systems and variations of charges are too familiar to admit of elaboration at the present hands insofar as concerns their fundamental principles, and are here briefly mentioned merely as prefacing a discussion as to how well they measure up to a thoroughly satisfactory schedule of charges for the average plant in commercial service.

The application of the Hopkinson principle to a system of rates may be questioned in particular cases upon the ground of inexpediency, but the fundamental soundness of the principle itself cannot be attacked because it is based upon principles of fairness as between the consumers themselves and as between the individual consumer and the plant serving him. To determine the exact details of the application of this principle to a schedule of rates for a partic-

ular plant and locality, which shall work substantial justice as between consumers of widely differing load and service conditions, and as between consumer and the plant supplying him, and at the same time fulfil the other conditions of satisfactory system of rates, is not unattended with considerable difficulty. It is rather the complexity of the problem than its quality that gives rise to the difficulty, and this complexity is such that it is my opinion that rates based upon costs alone as determined according to the Hopkinson principle are open to considerable criticism, and do not furnish a satisfactory solution of the rate problem, broadly speaking.

Practical modifications of the Hopkinson principle and actual commercial schedules of rates have been worked out by the previously mentioned Mr. Arthur Wright in England and more recently by Mr. H. L. Doherty and Mr. L. R. Wallis in the United States, not the least valuable contribution being by Mr. Wallis, though one seldom sees his name mentioned in connection with the subject. Practically all these have divided the expenses of supplying electricity into two classes, viz: those costs which are independent of the amount of electricity delivered to the consumer, and those which depend directly upon and vary more or less closely with the actual amount of electricity delivered. These two classes of costs are generally termed, "Fixed Costs" and "Variable Costs." To these is sometimes added a third classification, being costs which vary more or less in proportion to the actual number of consumers served and sometimes termed "Service Costs."

Owing to the peculiarities inherent in the supplying of electricity, the proportion of fixed costs to the total expense is extraordinarily large, taken in comparison with most other business undertakings, owing largely

to the before-mentioned fact that a plant must be large enough to take care of the peak conditions, which necessitates an outlay for equipment that must stand idle some twenty-odd hours per day in the average plant. From this it must be apparent that an increase in the output of a plant which does not necessitate a larger investment must result in a proportional increase in the variable costs, but will not increase the fixed costs to any appreciable extent and so must decrease the average cost per unit delivered. This has given rise to the term "Load Factor," which shorn of technicalities means the length of time that the demand is used each day, or may be expressed as a percentage of the total possible.

That this is true of the plant as a whole no one will deny, and it is further usually assumed that what is true of the plant as a whole is also true of the individual consumer. That is to say, it is usually considered that the central station supplying an aggregation of separate consumers is to all intents and purposes the same as if it were actually an aggregation of the requisite number of smaller plants which would be necessary to supply them individually, with the corrections necessary by reason of the fact that all of the consumers do not require their maximum coincidently. Or to put it in the language of another in defending a system of rates based upon this principle. "The cost of an electric lighting (and power) company are actually the sum of what its customers' costs would be if they supplied themselves under the different conditions under which current is consumed, less such deduction as is justified by the greater economy of the company's larger plant, and such deduction as is justified by the use of the same plant by different customers at different times."

Since different consumers use the plant at different times the determination of the particular cost of an individual consumer is a well-nigh impossible task. To determine this cost even approximately, account must be taken of the ratio of the sum of the customers' demands to the station demand, or the "Diversity Factor," the significance and importance of which should not be under-estimated. Accuracy in this process of correction for diversity factors certainly requires that the fixed costs should be apportioned as between lighting and power or peak load and non-peak load. Most makers of rate schedules have recognized the desirability of such a division, but, because of the obvious impracticability of making it, no one, so far as is known to me, has thus far attempted it. However determined and applied, the so-called diversity factor does not determine the actual cost of supplying the individual consumer, taking into consideration his individual conditions, but rather the supposed cost of supplying him, assuming that his supply is upon the average conditions.

Since, in the application of this principle to a commercial system of rates, it is assumed to assess to each consumer substantially the cost of supplying that consumer, including a reasonable profit, the final justification of any system of rates based upon individual costs alone must rest upon the practicability of ascertaining these individual costs with a reasonable degree of accuracy, and so devising the schedules of rates that they will automatically apportion to each consumer his pro rata of costs regardless of the character of his load and the circumstances of its use.

This is no small problem; and it would seem inexpedient to base a system of rates upon costs alone, as in event the rates were called to account before legal authority, the

company would be required to demonstrate that it is practical or possible to determine these costs with reasonable accuracy, since under this theory alone no consumer should be served for less than his cost of supply, and probably legally could not be made to pay more. This point, however, so far as I know has never been decided by any court of final authority.

The demonstration of the justness of a system of rates based solely on individual costs would be a fairly easy matter if all consumers were furnished with substantially a similar character of service; but they are not and even for a particular consumer the investment for which he is held to be responsible is not an amount ascertainable once for all, but an amount dependent upon his maximum demand, which may vary widely from time to time without any influence upon the company's investment.

In most of the discussions on rates for electricity supply the standpoint has been that of the company; but it should not be forgotten that a company supplying electricity to a community for light and other uses is a public servant and as such has certain definite duties to perform. This has too frequently been forgotten in the past, and has given rise to agitation for municipal ownership and more latterly to agitation for commissions to regulate public service corporations properly. It is therefore not unthinkable that if this public duty be too greatly overlooked in the future, it is likely to be brought to the attention of the offending company very forcibly by some legal authority. In this position of public servant it is the manifest duty of the company to supply all consumers applying, who are within the prescribed limit, and if one may judge from certain decisions in railroad rate cases, it might even be held that they must be served

although the particular individual consumer should cause an actual loss, provided the total average profit be not thereby impaired. The general problem is therefore further complicated by the fact that the company may not at its discretion serve one consumer and refuse another, but must serve all within reasonable bounds and without discrimination.

Another phase of the problem in my estimation has not in general been given due consideration in discussions of the rate problem. The kilowatt-hour is the established unit for measuring electricity. This unit represents a definite entity. Given equally efficient means of using electricity this unit will do quite as much work at one time as another, or produce as much light, as the case may be. Unless a given consumer is so situated that he can generate his own electricity, he has no direct measure of value for either the service or the energy supplied to him. Furthermore, it has no necessary relation either to the length of time he uses it nor to the demand he has made upon the station. The only measure of value to him is the cost of the same or of similar results produced by other means. The price or rate, therefore, should be such that it will be cheaper for the consumer to use electricity than the other means of producing the results; or if not cheaper, then the added convenience should be sufficient to attract the business against the advantage of cost by the other method. In event the company furnish free lamp renewals this must be taken into consideration in the rate for illuminating service.

It may be admitted that the length of use of the demand has considerable influence upon the cost of serving a given consumer, but unless the difference in length of use be sufficiently

marked, the results may be rather less important than is usually considered and in certain cases may be entirely negligible. It is also true that one large consumer is preferable in general to a large number of very small ones whose aggregate load equals that of the larger consumer. But I am not convinced that either of these conditions singly, or in combination, of themselves necessarily constitute individual differences in costs upon which differences in price to consumers may be properly based. However, since as a general truth either of these statements may be accepted as correct, they may have an important bearing or influence upon differential rates based upon a combination of circumstances.

Whatever may be said in criticism of the application of the Hopkinson principle to a practical system of rates in general, it certainly forms an almost ideal method of figuring against an isolated installation, since in this case the cost of the consumer to furnish his own lights or power, as the case may be, follows exactly the same general lines. If it be admissible then to make a distinction between competitive and non-competitive business, this character of business would be classed as competitive and in general subject to the conditions usually applying to such business.

On the other hand, there is much to be said in favor of a uniform meter rate. It is simple, definite, and easily understood and applied by the average consumer and it is easily handled from the accounting end. It is, too, a comparatively simple matter to

determine with a given plant what flat or uniform meter rate will give a fair return on the investment. In general, however, this uniform charge would be largely prohibitive in the case of competitive business and would therefore limit the output of the plant to such extent as to materially increase the average cost per unit of output.

In the final analysis, there is, in my opinion, but one real basis of rate making, viz:—"what the traffic will stand." Of course there are considerations of cost involved, there being a point below which we cannot go in making a rate without showing a loss, and there are different methods of determining where the reductions in rate come in; but in and through all commercial rates the law of supply and demand make itself heard. There is and can be no rate sheet in which this is not the dominant idea, argue about it and deny it as we may. If the traffic will not stand a rate that will show a reasonable profit, then the rate should not be made. As an evidence of the truthfulness of the above, take the rate sheet of practically any large company and you will find a rate for signs, confessedly a peak load, that will net only a few cents per kilowatt-hour on a basis of some four hours per day use of the demand, where the readiness-to-serve rate for the same hours use of the demand, for residence lighting we will say, will be two or three times the rate for sign business. If not because of what the traffic will stand, these rates stand unexplained. So it is throughout the whole schedules, or nearly so.



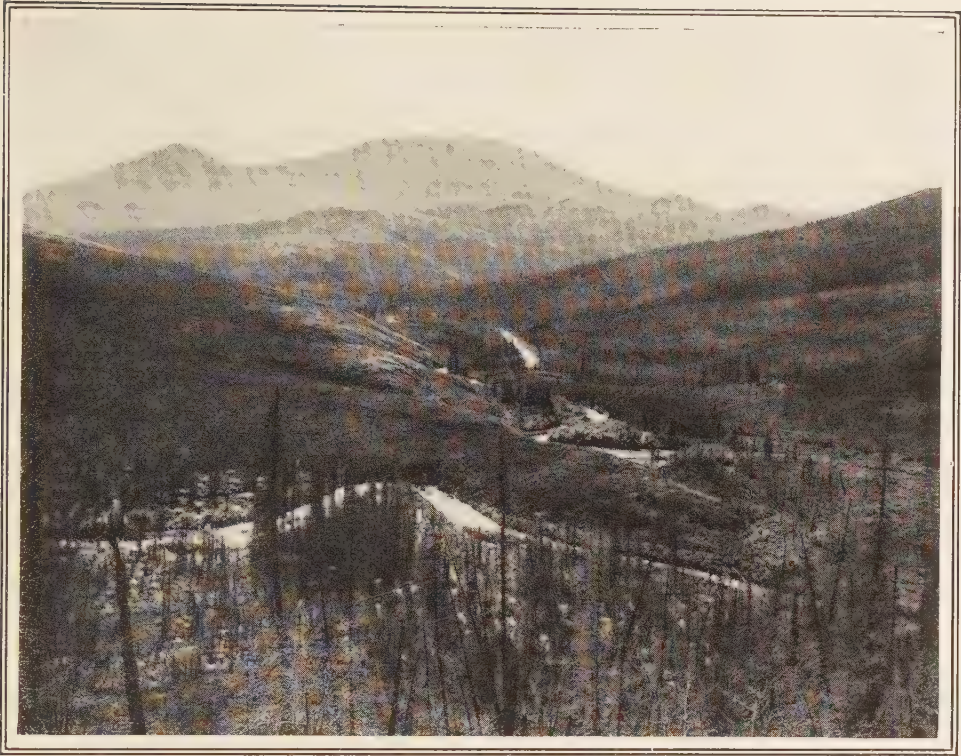
YANERT FORK, LOOKING UP STREAM

Showing flood-plain deposits in lowlands above the canyon of the Nenana River



ANCHORAGE BAY, FROM THE SOUTHWEST

Beyond the larger body of water (which is Chignik Bay) may be seen the Aleutian Mountains
All the illustrations are presented by courtesy of the Director of the United States Geological Survey



WOLVERINE MOUNTAIN FROM THE EAST, LOOKING UP QUAIL CREEK VALLEY, YUKON-TANANA UPLAND

ALASKA. A MUCH MISUNDERSTOOD TERRITORY

By Frank P. McKibben

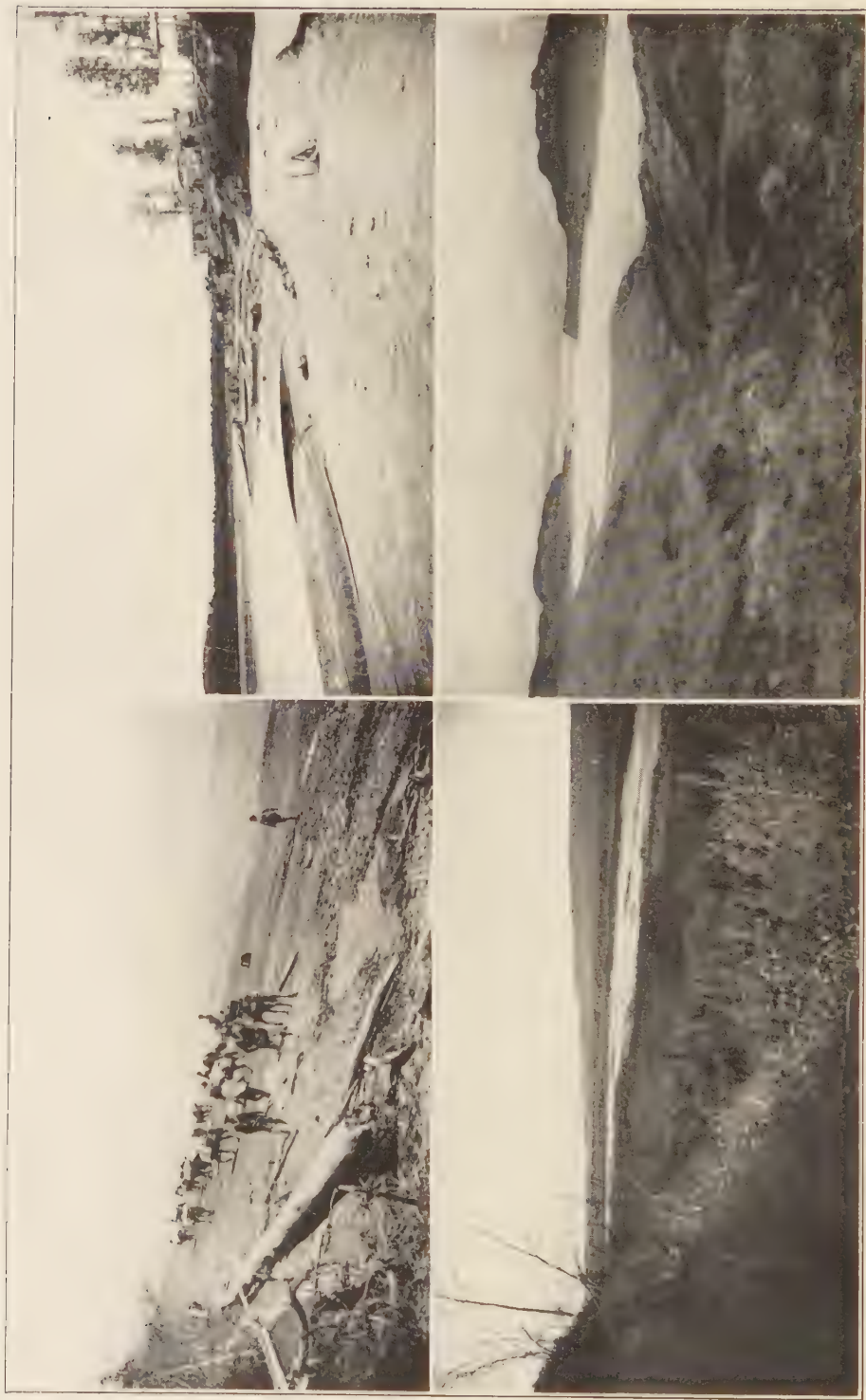
Alaska is intensely interesting because of its apparently huge mining and engineering opportunities, and especially of the acute struggle for their conservation. That the results so far have not been happy makes it more important to study any proposition for a "better way." Prof. McKibben draws sharply the distinction between "obstructive" and "constructive" conservation, and offers practical suggestions for a working policy.

For the use of the photographs accompanying his text we are indebted to the courtesy of Dr. George Otis Smith, Director of the United States Geological Survey.—THE EDITORS.

ALASKA'S greatest need at present is a first-class publicity bureau which will do two things and do them at once. First, spread broadcast before the people of the United States the facts regarding the physical features, the form of government, and the problems of this important section of the United States. Second, create a public opinion which will require Congress to

enact laws to establish an effective and businesslike local government and permit immediate commercial development.

Many people of the United States have very little accurate knowledge concerning Alaska. For example, few realize that in area it is over twice the size of Texas, and that besides vast quantities of mineral lands there are large areas which



TANANA RIVER AT TORTELLA
UNGA HARBOR FROM THE WEST

ALONG COOK INLET
LOOKING UP NENANA VALLEY

can and will be made agriculturally productive. Even the climate is little known. The opinion is prevalent that throughout the summer only low temperatures are to be found everywhere, whereas even in winter the temperature at such coastal places as Sitka seldom falls below zero Fahrenheit. Of course, extreme cold is found in the interior during the winter season. Last summer I visited southern Alaska, and as our steamer entered Sitka harbor a passenger, seeing some soldiers drawn up in front of the barracks on shore, asked if they were Russian soldiers, and recently a manufacturer in Massachusetts was heard to ask, "What country owns Alaska now?" Doubtless these are extreme cases, but it is a fact that information concerning conditions in our territory is far from being widespread. The character of the population is generally not understood, and it seems perfectly safe to assume that few people realize that one-half the inhabitants of Alaska are whites. A study of the population reveals the astounding fact that during the decade ending 1910 there was an increase of only one per cent in the number of inhabitants in this vast territory; namely, from 63,592 to 64,356.

Abounding in snow-clad peaks and mountain ranges and provided with a very large annual precipitation, the topography of Alaska is in parts ideal for the generation of water power which can be transformed into electricity and conveyed to convenient places for utilization. As the population is at present small and industrial

activity is not great there is little demand for this hydroelectric development, and except in the operation of a small number of mines and municipal plants, the tremendous water power is scarcely touched. But there are wonderful possibilities in this direction, and when the country has sufficiently progressed to warrant



GRASS AND TIMBER ON NIN RIDGE, KICHATNA VALLEY

it, streams in many sections will yield abundant power for all purposes, though in the interior the extreme cold will limit the output. Fiords lined on either side with snow-capped mountains rising several thousand feet from the water are very common. From these snow fields flow hundreds of streams which can be made to yield considerable power. Hence, when conditions warrant it, there is no reason why electric power

could not be utilized in some locations for propelling trains over railroads during a portion of the year. Trains operated by electricity generated from water power are in use in Norway and Sweden to a considerable extent, and the physical conditions in these countries are very similar to those along the coast of Alaska.

This wonderful territory is suffering from poor government. It is "high time" that a *constructive* in-

mission like that at Panama should prove satisfactory in Alaska. The Canal Zone is about 10 miles wide and 40 miles long, whereas Alaska has an area of nearly 586,000 square miles. Nevertheless, after Congress enacts the laws, the problem of developing Alaska is largely one of engineering, and commissions are proving the most effective means thus far devised for executing work of this nature.



TATINA RIVER VALLEY, KUSKOKWIM BASIN

stead of an *obstructive* policy be inaugurated. The honest people of Alaska are demanding it, and the present Congress should give it to them. But what form must the administrative power take? A commission similar to the Panama Canal Commission has been advocated, and even though there is great disparity in the sizes of the two areas mentioned, yet the actual execution of laws in Alaska and Panama could be made practically similar and a com-

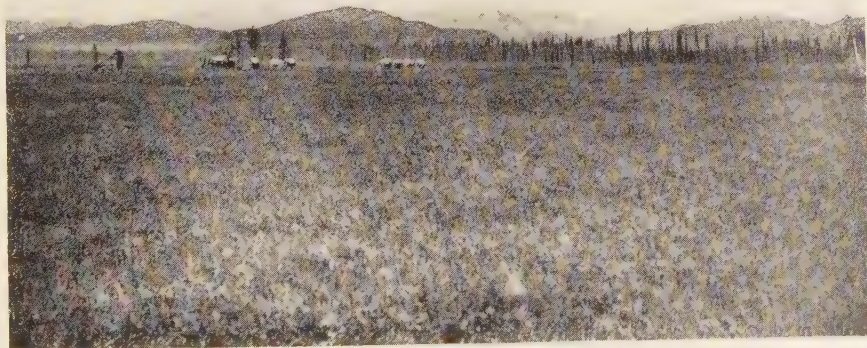
mission like that at Panama should prove satisfactory in Alaska. The Canal Zone is about 10 miles wide and 40 miles long, whereas Alaska has an area of nearly 586,000 square miles. Nevertheless, after Congress enacts the laws, the problem of developing Alaska is largely one of engineering, and commissions are proving the most effective means thus far devised for executing work of this nature.

It is certainly true that before the great interior of Alaska can be developed commercially as it should be, a great deal of engineering work must be done, and if a government-owned railroad system is to be constructed to permit this development to take place, a commission located in Alaska and having broad powers under congressional acts should prove much better than any other form of administration. The secret of success of Panama has been due largely to the fact that the chairman of the commission, the president of the Panama Railroad, and the chief engineer of the Panama Canal Commission are one and the same man. Having thus a very great authority as well as great power, and being as-

sisted in carrying on the various phrases of the work by capable men who understand the problems of construction as well as those of government, the chairman of the Panama Canal Commission has perfected the commission form of government to the highest degree. There is every reason to believe that similar results can be accomplished in the case of Alaska. After finishing a railroad system such a commission could supervise its operation; and if a rail-



COTTONWOOD TIMBER ON BELUGA RIVER



MEADOWS AND TIMBER FLAT NORTHWEST OF COOK INLET



VALLEY OF DALZELL CREEK, LOOKING SOUTHEAST



LIGNITIC COAL INTERBEDDED WITH WHITE SANDSTONE AND CONGLOMERATE, HEALY FORK



KENAI ROCKS ON ADAMS CREEK, A TRIBUTARY OF THE TOTATLANIKA, AT NORTHERN FRONT OF ALASKA RANGE

way line served as an outlet to a mining region in which several companies were operating, these companies could be reasonably sure that all would receive equitable treatment.

Much has been written regarding the coal and mineral lands of Alaska and many legal battles have been fought and remain to be fought concerning them. It is not with the past,

however, that this article deals; its purpose is rather to emphasize the wonderful possibilities and to point out the necessity for intelligent action of a constructive nature. Suffice it to say that under the present interpretation of the laws by the Government Land Office, no individual can secure more than 160 acres of coal lands, and under no circumstances



GLACIER COVERED RIDGE BETWEEN PETERS GLACIER AND MOUNTAIN FRONT, NINE MILES NORTHWEST
OF MOUNT MCKINLEY

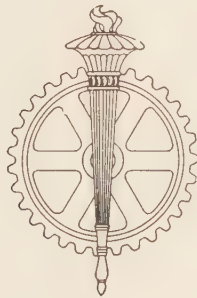


GLACIER OVERRIDING RIDGE OF ALASKA RANGE NINE MILES NORTHWEST OF MT. MCKINLEY

can there be an association formed for the purposes of mining or controlling the coal from more than 320 acres. Clearly, under such a scheme no development worthy of the name will take place. Capital in large sums is needed. It is idle to suppose that coal on 320 acres of land will attract capital. Hence it is that there are possible three arrangements for developing the coal and other minerals on a large scale. The adoption of any one of these will prove a great boon to Alaska. First, the Government may sell the land outright to corporations or individuals in quantities of sufficient size to make mining attractive. Second, lands may be leased by the Government so the lessee shall pay a royalty to the Government on each ton of coal mined. Third, the coal may be mined, transported and sold by the Government itself. We have then the three possibilities: private ownership, the leasing system, and Government ownership. It would seem that the best results could be secured by a leasing system under which the coal would be mined by corporations or indi-

viduals. The royalty paid to the Government should be used for further development of the territory. To prove useful, a leasing system must be carefully framed, wisely and honestly administered. In coal mining, for example, if the leasing company were so disposed, and were not restrained, it might mine the coal in a way as to remove only the very best and to waste the inferior grades because by so doing it would reap greater returns for a given expenditure of capital. For this reason if proper governmental control be exercised over the leasing corporations, it appears that it would be best to have large corporations engaged in mining because such aggregations of capital can practice methods of mining which would prove more efficient and therefore more economical than methods used by small companies or individuals.

Under a careful planned leasing system administered by a competent commission, using the income from leases for extensions, commercial activity in Alaska will expand and true conservation be secured.



LABOUR UNREST IN THE UNITED KINGDOM

II. REMEDIES AND REFORMS

By John B. C. Kershaw, F.S.S.

An examination of the chief contributory causes of the labour unrest in the United Kingdom appeared in the preceding issue of this magazine. It is Mr. Kershaw's purpose in this second contribution to the discussion of the subject, to consider in some detail the remedies that are suggested by a study of the conditions disclosed in the earlier article. As pointed out in that contribution, many causes—political, social and industrial—have combined to create the serious and widespread unrest which is now manifest in the lower ranks of the world of labour in the United Kingdom, and for this reason, no one remedy or reform can be expected to restore industrial peace, although it may relieve the tension of the present situation.

If this diagnosis be correct, a combination of causes will demand a combination of remedies before the industrial and social organism can be restored to a state of sound and vigorous health. Below, the author sets forth what in his opinion are the more important changes and reforms that are required, to effect the object in view.—THE EDITORS.

INCREASED cost of food and the rising standard of comfort and luxury demanded by the workers, were named in the previous article as the most important contributory causes of the present industrial upheaval; and if this be correct, reforms affecting rates of wages and hours of work will have the most influence in alleviating the existing situation. How far these demands for increased wages and for reduced hours of work can be met, without seriously endangering the position of the United Kingdom as a competitor in the world of international trade is doubtful, and remains for the future to disclose.

I. REFORMS AFFECTING RATES OF WAGES AND HOURS OF WORK

The claims for increased wages made last year on the part of the lower ranks of labour in the railway world, were no doubt moderate and justifiable. An increase of 2 shillings per week upon a weekly wage of 16 shillings to 18 shillings was not excessive, and in my opinion was supported by the increased cost of food. The Great Western Railway Co., in fact, granted a wages increase of 10 per cent to *all* grades of labour in their employ, and reduced the

hours of labour in the signalling department of their line. When considering the comparatively low rates of payment made in the lower ranks of railway service, however, it must be remembered that employment by the English railway companies carries with it certain advantages that are not customary with ordinary employment. The chief of these advantages are:—

1. The employment is permanent, a feature of great importance to all working men, and especially so to the unskilled.

2. There is opportunity for promotion from any grade to any grade, if ability and industry warrant it.

3. Free clothing. A long article in the *Railway News* of August 19, 1911, gives the fullest details of the free uniforms and clothes supplied to twenty grades of railway employees, from stationmasters to van-boys, including guards, shunters, brakemen, signalmen, messengers, porters, and others.

4. There are insurance and relief funds which receive substantial financial aid from the companies.

5. Pension or retirement provision (two of the companies at least provide old-age pensions free).

6. Free passes. A certain number of free passes are granted to the servants of the companies, including their wives and families, over their own lines and sometimes over the systems of other companies. Return tickets at half single-fares are also issued, without restriction as to number, to railway servants, their families, and even to other relatives.

7. Annual holidays, varying according to length of service, are granted to most grades without loss of pay.

Advantages 4 and 5 will, of course, be extinguished by the new insurance law, which comes into force on July 1, 1912, but the others remain, and quite explain the otherwise low rate of pay for unskilled labour in the railway world. The total number of men and boys employed on the railways of the United Kingdom is 608,754, and of this total 43,584 are boys. The statement made during the 1911 agitation that 100,000 employees of the railway companies received wages that averaged less than £1 per week, was misleading, for those who made it did not point out that 43,584 boys were included in this total.

As regards the advances claimed and obtained in 1911 by the workers in other branches of unskilled labour, that granted in the dock and shipping industries might be justified by the same line of argument, although the increase of 33 per cent granted to one section of the London river-side workers would certainly seem to be excessive. But if the wages of the lower ranks of unskilled and casual labour are to be permanently increased by 10 to 25 or 30 per cent as a result of the recent agitation, the movement is bound to spread to the more highly-paid ranks of labour, and there will be witnessed a demand for similar proportionate increases in the wages of those engaged

as skilled workers in all branches of manufacturing industry. The disastrous general strike of the coal miners for the payment of a statutory minimum wage ranging from 5 shillings to 7 shillings 6 pence per day in all districts is but the first indication of this coming industrial agitation for higher wages on the part of the skilled workers of the community.

There are few industries and manufacturing, however, now carried on in the United Kingdom which yield a large or excessive return upon the capital invested in them; and the labouring men and their leaders are entirely misled in thinking that these advances in wages can be paid out of the present profits, and that the result will be simply to reduce the interest on capital. As shown by the compromise arrived at by the railway settlement of August 19, 1911, the result of granting concessions to the men *must be, increased cost of the commodity or service to the general community*; and the still more recent settlement of the coal-miners' strike will only serve to emphasize the truth of this economic principle.

Since the United Kingdom is practising a policy of "free-trade" (or more correctly of "free-imports") those controlling British industry cannot allow this movement for increased wages to spread, unless prepared to sacrifice either their trade or their policy of free-imports. Every rise in the rate of wages and every improvement in the social and economic position of the worker, has to be paid for ultimately in the price of the article made or of the service rendered, and therefore such increase must handicap the nation in its endeavours to maintain its place in the industrial world. Unless checked, this movement for increased wages in the United Kingdom will certainly entail, either the adoption of some

system of tariff reform, or the loss by the home manufacturers of the larger portion of the external and internal trade of the country.

The blindness of the present leaders of the Official Labour and Trades Union parties in England, to the fact that these are the only two alternatives if the present agitation is continued, does little credit either to their intelligence or to their common sense.

It is not my purpose in this article to discuss the pros and cons of tariff reform, but it may be pointed out that Mr. Chamberlain and the early advocates of this policy saw clearly its bearing upon the situation with which we are now confronted, and made the improvement in the social and economic position of the worker one of the main planks in their platform. The policy was defeated by the votes of the workers themselves, at the elections of 1906 and 1910, and there is room for irony in the reflection that the existing unrest in the labour world is thrusting the men and their leaders irresistibly towards the adoption of a policy which they have twice rejected within the last five years.

The chief hindrance at present to the advancement of more reasonable demands, and to the spread of more correct views of the situation, is that the majority of men have become dupes of those who assert and believe that a minimum wage of 40 shillings per week for unskilled labour is possible *under the present conditions of industry* in the United Kingdom, and that by a repetition of the recent general railway-workers' and coal-miners' strike, on a still larger scale, this wage can be obtained.* Labour Arbitration Boards and Conciliation Boards, though they may bring the representatives of masters and men

together, can do little to effect a settlement of the wages question while this belief is being instilled into the minds of the workers by those who appear to be their real leaders and until the influence of these men is undermined, the present period of unrest and agitation is likely to continue. The arrest of Mr. Tom Mann, the apostle of Syndicalism and the most dangerous of the modern labour agitators, is, it may be hoped, the first step towards a better state of affairs.

The proposals of Mr. Will. Crook's bill for settling labour disputes, suffer similarly from grave defects. A master or a manufacturer may be coerced into accepting the award of the arbitration board by the magnitude of the fine of £50 for each day's delay; but to fine a working man who declines to accept the award £2 is a more difficult matter, and the coercion which the bill proposes to apply to unwilling workers is practically worthless.

In my opinion the most hopeful method of dealing with the present demands for increased wages and shorter hours is by an extension of the system of co-partnership, which has already proved successful in many industries. It differs from the present system in the fact that the workers are given a direct share in the surplus profits of the business, and are urged to invest their savings in the shares of the company under which they find employment.

Co-partnership differs from Mr. Tom Mann's scheme of *co-operative production* as outlined in the *Daily Mail* article already referred to, in that the capitalist and the labourer recognize their mutual dependence one upon the other for the successful conduct of the manufacture or industry in which they are engaged; and no attempt is made to dispense with the services of the skilled finan-

*See Mr. Mann's article in the *Daily Mail* of August 17th, 1911,

cier and technically trained manager, in the control of the business.

Co-operative production has been practised in this country for over thirty years with but little success, the reasons being that the management of machinery and plant, the control of workers and the financing of business on a large scale demand qualifications and abilities that are seldom found either in the working man or in his so-called leaders. The majority of factories worked on a co-operative basis have been small undertakings, employing but little capital, and yielding but poor security and returns, either to those who have advanced the money to build and equip them or to the workers engaged in them. The only form of co-operative production which can attempt to cope with the demands of modern manufacture is, in fact, one which can be superimposed upon our present system of capitalised industry, and is that known sometimes as *profit sharing*, but more correctly as "*co-partnership*."

As already stated, this system has been adopted with success in many of the more progressive works of the United Kingdom. In a series of articles contributed to this magazine in June, July and August, 1903, I gave details of many of these schemes, the majority of which are still in operation. Messrs. Lever Bros. at Port Sunlight, Cheshire, have developed their scheme to allow of the employees investing a share of the profits in the business; and between 1,000 and 2,000 of their work-people now hold shares of the firm, and are receiving upon these a good rate of interest. The few failures that have occurred (the most notable being that of the scheme initiated by Sir Christopher Furness at Messrs. Irvine's shipbuilding yard at West Hartlepool in 1909) have been due to

the hostility of the trades unions and their leaders, rather than to any fatal and inherent defects of the principles of co-partnership. That schemes of this character are receiving increased attention as a means of solving the wages question, is proved by the fact that the chairman of the Great Eastern Railway Co., in his evidence before the Railway Commission on September 18, 1911, stated that the initiation of such a scheme had been seriously discussed by his own board of directors in 1899, and that its consideration had been dropped only because of the poor returns to the shareholders in the years of bad trade and traffic that followed the outbreak of the war in South Africa. The subject of applying co-partnership principles to British railways has been recently discussed in the *Times* and in the *Railway Times*, and the following extract from the issue of the latter journal for September 30, 1911, shows that this method of solving the railway wages problem is not so hopeless as many business men are disposed to believe:

The profit fund for division between the stockholders and the employees is taken as the amount of revenue remaining after the deduction of working expenses and of interest upon capital, at the existing rate upon stocks bearing fixed interest, and at the average of the past three years upon ordinary stocks, with a maximum of 5 per cent. This method of calculating the amount of the profit fund gives the following results, assuming the scheme to have come into operation on January 1, 1910: London and North-Western, £897,093; North-Eastern, £415,243; Midland, £390,979; Great Western, £286,651; Great Eastern, £95,176; and Lancashire and Yorkshire, £94,796.

As to the allocation of the profit funds, it is taken in the proportion which the interest on the paid-up capital on the one hand, and the amount of wages paid to the staff entitled to participate in the scheme, on the other hand, bear to their sum. Taking the interest payable upon the ordinary stock as 5 per cent in all cases, the employees' share of the profit fund would be as follows: London and North-Western,

£333,677, equal to £11 6 9 per cent of wages paid; North-Eastern, £148,233, or £8 2 8 per cent of wages; Midland, £146,723, or £5 1 1 per cent of wages; Great Western, £97,720, or £4 1 2 per cent; Great Eastern, £30,126, or £2 15 8 per cent; and Lancashire and Yorkshire, £31,116, or £2 10 1 per cent of wages paid.

The objections of the men's leaders to the system is perhaps natural, for it substitutes co-operation for antagonism in the relations of masters and men, and if generally adopted, it would inaugurate a period of industrial peace, in which the strike agitator would find his occupation gone.

The hostility of trades unionists and their leaders to co-partnership might be overcome, however, by a guarantee that the system should be *based upon the payment of trades-union rates of wages* for each branch of skilled or unskilled labour engaged in the industry, factory, or works where it was adopted; and that the right to share in the surplus profits should not be counterbalanced by fines or deductions from this minimum wage, when profits were non-existent.

In an article published some years ago in one of the best known engineering weekly papers the fact that in certain years nearly every manufacturing business failed to earn profits was made the basis of an argument to prove the impracticability of schemes of co-partnership as a solution of the labour question, since no working men would accept its logical concomitant, *loss sharing*.

I disagree with the conclusions arrived at. They may be logical, but in business affairs logic does not always lead to economy. Even if the workers be regarded simply as machines, it pays to keep them in good working order. To make the employees share in the losses of the firm would impair their collective efficiency. No wise manufacturer, in times of loss, spends less upon the maintenance of his machinery and

plant; for he knows too well that in the long run such a policy costs more than it saves. To cut down the wages of the employees in times of loss to a bare maintenance point, or even below it, would similarly be foolish economy. It would lead to the migration of the best workers to other firms, and to the depreciation of the remainder considered merely as working machines.

Schemes of co-partnership, in my opinion, should therefore be based upon (1) a fixed minimum rate of wage for the worker, regulated by the trades-union rate for the particular work and locality involved; (2) a fixed rate of interest for the capital employed in the business; a rate which would vary according to the nature of the industry or manufacture, and of the risks involved; and (3) a division of the surplus profits, after payment of interest and all other fixed charges, in definite and agreed proportion, between capital and labour. The workers' share of the surplus profits could either be drawn in cash, or invested in the business, at their own option.

Limits of space will not allow further discussion in this article, but the subject will be further dealt with in next month's issue of this magazine, and examples of successful co-partnership schemes in Great Britain will be given. Co-partnership on this basis would, I believe, satisfy the majority of reasonable trades unionists, and would provide a solution for the wages problem which now confronts not alone Great Britain, but every manufacturing nation. Such schemes, when adopted, would give the workers in every industry an intelligent and personal interest in their success; would make them realise the losses to the whole community that result from lock-outs and strikes, and would save them from making impossible and im-

practicable demands in regard to rates of wages and hours of work.

As already stated, many of the most prosperous firms in the United Kingdom are now working on this system; and a wide extension of the movement is assured, as soon as the hostility of the trades unions and their leaders is overcome. Possibly to install the latter *as paid representatives* of the men on the boards of a few of the larger railway and industrial companies would remove the difficulty; and it is noteworthy that the South Metropolitan Gas Co., and Messrs. Lever Bros. have already appointed workmen to their boards. The insight which the men's leaders thus obtain into business methods and business risks is a most valuable educational experience, and assists greatly in widening their mental outlook upon industrial questions.

II. REFORMS AFFECTING THE CASUAL LABOUR AND HOOLIGAN PROBLEM

So much space has been devoted to the wages question that the reforms suggested by a consideration of the other causes of the present labour unrest can be dealt with only briefly. The disproportionate growth of the casual labourer and hooligan element has been due, as shown in the first article of this series, to the continued emigration of the more self-reliant and efficient surplus of our population, and to the decided check to the investment of capital in home manufacturing industries that has occurred during the past ten years. Other contributory causes are, the increasing number of boys and youths turned out from blind-alley occupations, and the greater extent to which machinery is displacing the skilled worker in all manufacturing industries. The skilled mechanic and handicrafts man of the past generation is gradually being displaced by youths

and men who are mere "machine-tenders." These, when unemployed, drift naturally into the larger towns and swell the ranks of the casual labourer and city loafer.

The main remedy for the evils of the present position is to restore the confidence of capitalists, and to obtain a greater flow of capital into home manufacturing industries, while at the same time encouraging in every possible way the settlement of suitable men on the land, under some scheme of English land purchase based on the Irish model. The abortive attempts of the past have shown the futility of trying to convert the city loafer and idler into an agriculturist; and the most that can be hoped from any scheme of land reform is that it may arrest the further drift of the country populations into the towns, and provide work on the land for an increasing number of those who have been born and bred in agricultural districts.

The manufacture of hooligans should also be stopped at its source, as regards one fountain head, by discouraging the entrance of boys into blind-alley occupations; and by making the parent or the employer responsible for the attendance of boys who enter such occupations at a technical or evening continuation school, learning some useful trade.

But, as already stated, the most hopeful remedy for the casual labour and hooligan difficulty is *more work*; and the provision, for these classes of our population, of regular employment at a rate of wages which will enable them to live decent and moral lives. Under-employment is at the root of this problem, and only when confidence is restored and British industries show once again the expansion which characterised the middle and latter years of the nineteenth century will it be solved.

The question of restoring the confidence of capitalists in the stability and future of British industry has become, however, owing to the policy and administration of the present Government, largely a political one, and no impartial observer can doubt that the overthrow of the existing Liberal-Labour régime, and advent of the Unionist party to power, will be necessary before this end is attained.

III. REFORMS AFFECTING THE LEGALITY AND CONDUCT OF STRIKES AND THE MAINTENANCE OF LAW AND ORDER DURING LABOUR STRUGGLES

The inconvenience and dangers to which the law-abiding portions of the population of Liverpool and other northern cities were exposed, during the strikes and riots of August, 1911, have created a strong demand for legislative action, in order that a recurrence of such disorder and strife may be avoided in the labour struggles of the future.

The Associated Chambers of Commerce of the United Kingdom at their Annual Meeting of 1911 at Dublin, and the Liverpool city magistrates, have formulated a strong demand for the repeal of the clauses of the "Trades Disputes Act" of 1906, dealing with what is miscalled "peaceful persuasion," and all moderate and fair-minded opinion in the country will be found, it is believed, on the side of this demand. As pointed out in the previous article, the strike leaders and strikers themselves, in their speeches, denounced violence and intimidation, but made no actual efforts to suppress it; and there is good ground for the belief that although non-strikers and hooligans may have started much of the stone-throwing and disorder during the

strike-riots of 1911, the strikers themselves rendered active assistance before the disturbances ceased. If "picketing" cannot be conducted without the violence and intimidation witnessed everywhere during recent strikes, it must be made illegal; and it is certain that the present or next Government will find it necessary to deal with this question at an early date.

That the *general strike* should be made illegal, and that those who advocate it by public speech or action should be dealt with under the criminal law, is another demand that has been put forward during the recent labour troubles in Great Britain. The present English Government, dependent as it is for its continuance in office upon the labour vote, is unlikely to accede to this stringent reform; but it is noteworthy that in Australia, a Labour Government has taken even stronger action on this very subject, and has defeated the efforts to bring about a "general strike" by deporting the agitators who promoted it. Until similar action is taken in the United Kingdom by the next Unionist Government the dangers and inconvenience caused by a general strike, if this should occur, may be minimized by three administrative reforms that will not require Parliamentary sanction. In the first place, there should be much less hesitation in adopting stern methods upon the first signs of violence and intimidation. It has been said wisely that had the shooting which occurred in Liverpool in August, 1911, taken place at the commencement rather than at the end of the struggles between the riotous mobs and the police much bloodshed and suffering would have been avoided and peace would have been more quickly restored. The national tendency to allow things to get into a hopelessly bad state before taking

the necessary vigorous measures to improve them was never more fully illustrated than during the recent labour troubles in Liverpool and London, when supplies of food and other necessities of life were held up for days by the strikers and their supporters—the hooligans and street-loafers, with the police and military looking on as spectators.

In the second place, the municipal employees engaged in the public lighting, scavenging and tramway services of all large towns and cities, should be re-engaged upon a new basis, and should be absolutely freed from the possibility of being called out in support of a general strike by an outside committee of strike-leaders. There would not be the slightest difficulty in re-engaging these men, on the basis upon which the workers in water-supply undertakings are engaged. Many of these men only joined in the 1911 strike, owing to the violence and intimidation to which they and their families were subjected by the strikers.

Finally, all large towns and cities should follow the example of Liverpool, and draw up a permanent list of citizens ready in times of emergency to undertake responsible work and duties, either as special constables or in some other capacity of social service. The middle and upper classes of British society contain in their ranks, thanks to the popularity of open-air games and sports, a fine reserve of healthy, muscular young men; and the working classes of England may yet discover that the country can manage to provide itself with the real necessities of existence for a week, or even a month, without their aid or assistance. A general strike from its nature must be *short*, for there would be no funds available to make strike payments to all who joined in it; and to withstand the

claims of the men for a week or a fortnight would most probably cause their defeat. The mayors and watch committees of all large towns and cities affected by the recent strike in the northern manufacturing districts have already organized civic defence leagues of workers in order to be prepared for the next general strike when it is declared.

As regards *the spread of a lawless spirit amongst the working classes, and the lack of discipline and restraint shown during the recent strike agitation* by the younger generation of working men, the remedies must be sought in the homes and in the schools of the people. The slackness of parental and school discipline that has characterised the upbringing and education of the present generation of wage-earners is responsible for the lawless spirit that we see around us, and no improvement can be expected until parents and teachers more fully exercise their authority.

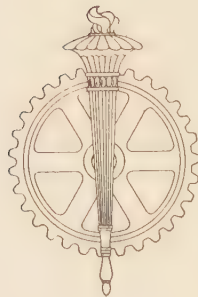
The false sentiment of an age that considers all forms of corporal punishment superfluous in the training of children and men must be got rid of at all costs. The adoption of some system of compulsory physical training for all youths between the ages of 18 and 21 would prove also a great aid to the inculcation of habits of discipline and self-restraint, and on this ground alone I am a firm believer in, and supporter of, the proposals of Lord Roberts and the National Service League for introducing a modified form of compulsory military training into the United Kingdom. The Baden-Powell boy-scout movement is doing a great work in the training of the rising generation of young boys in these characteristics of true manliness, but something more and beyond this is required to correct the great and crying deficiencies of

our present system of elementary education.

The value of early training in habits of discipline, cleanliness, and obedience is incalculable in after life, and the present position of Germany as a manufacturing country, is due partly to the lasting effects of the military discipline and training, which all the physically-fit in that country, have received in their youth. One of the most notable things in the reports of the numerous English Working-Class Deputations which have visited Germany during the last ten years, in order to study the developments of her manufacturing industries, has been the commendation of the cleanliness, orderliness and splendid organisation of the larger works, and of the work-people engaged in them.

Such scenes as were witnessed in Liverpool and in South Wales during the recent labour troubles would have been impossible if the working classes of the United Kingdom had received any early training in habits of discipline, obedience to authority, and self-restraint; and it may be hoped that one result of the recent strike disturbances will be to increase the number of adherents and supporters of the National Service League and Boy-Scout movements.

In the third and final article of this Series, details of the progress of the *Profit Sharing and Labour Co-partnership movement in the United Kingdom*, since the date of my earlier contribution on this subject, in *THE ENGINEERING MAGAZINE*, June—August, 1903, will be given.





EDITORIAL COMMENT

THE TITANIC DISASTER

TITANIC, indeed! Only in an age when man has dared so much could so colossal a response to his daring be hurled upon him. For this is unlike great cataclysms of Nature which have overwhelmed communities in what are really the modern vestiges of great geological changes. The encounter in which the latest and most perfect marine creation went down, was one of man's own provoking. The greatest engineering work ever created by human hands and brains, the fruit of years of thought and toil, puts forth with confidence unreached even by the faintest suggestion of uncertainty. And before half the chances of a single ocean crossing have been met Nature has given her answer. The Titanic is crushed by her ice monsters as certainly, as relentlessly, as utterly, as any frail shell in a wild bird's nest is crushed by the driving hail. The vast bulk, the vast dynamic energy of this mechanical creation are turned to its own destruction.

Exactly what happened, or how, can not be known until after these pages are printed. At the time of writing it is inexplicable that the bulkheads, the whole compartment and cellular system of construction could have failed so completely.

Two things of broader significance, however, seem clear. The first is that the disaster is characteristic of the modern system of colossal centralization. The vast ship, like the vast business, depends ultimately on the individual—the single judgment. And when that one mind errs, as at any moment it may, and inevitably at some time it will, colossal disaster

follows. Second, the speed mania which imposes even upon the most experienced, the most cautious, a disposition to take chances which their judgment should prohibit, has, it is greatly to be feared, a large part in the responsibility for this horror.

For one thing we may hold ourselves proudly, even amid the universal grief. It appears from every report so far received that "the saved are mostly women and children." The highest traditions of our folk, who have ever braved the sea even when it slew them, seem to have been honored again in this greatest of ocean disasters. Over such spirits the sea asserts its dominion in vain.

THE EFFICIENCY SOCIETY

THE Efficiency Society, whose preliminary organization we announced and discussed in our mid-winter issues, has been formally inaugurated and permanently established with an enrolled membership of nearly one thousand. The character of this membership, at once authoritative, comprehensive, and associated generally with important achievement both material and intellectual, is ample evidence of the Society's power for practical good. Several highly definite and most interesting proposals for specific work are under consideration. There is every reason to hope that, at its next public meetings, it may be able to contribute something of convincing value to the data both of preparation for efficient industrial management, and of the benefits actually received by the introduction of "Efficiency Methods" under practical conditions in industrial establishments.

SHALL WE CHANGE OUR PATENT SYSTEM?

ONE of the most important questions lately raised before an audience largely interested in producing or marketing manufactured products is that of a possible reorganization of our patent system. It has become so interlocked with our entire industrial system that any change would almost inevitably produce effects reaching farther and deeper than could well be predetermined. Abuses have undoubtedly grown up, and a growing demand lately appeared for earnestly desired, and seemingly desirable, reforms.

These, however, were in the administration of the system rather than in its fundamental conceptions; and the agitation that has sprung up since the Supreme Court reaffirmed the fundamental law in its decision in the Dick case is turned in a different direction and seeks entirely different purposes from those held by the erstwhile party of patent reform.

It is curious that the Dick decisions should be taken (as it is in the popular view) to define some new principle not heretofore recognized. Comment in the public press is for the most part based on a wholly mistaken supposition that the court has read into the law some new interpretation extending monopolistic powers. It has done nothing of the sort, but has merely decided this special case upon an old and thoroughly established principle organic to the patent system. Mr. Edwin J. Prindle pointed this out six years ago in his articles on "Patents as a Factor in Manufacturing," which appeared in this Magazine and have since been republished in book form. He cited instance after instance of restrictions as to use that were unquestionably

valid and in any court would "bind the purchaser" who has notice of the restrictions." Among these (page 43, "Patents as a Factor in Manufacturing," edition of 1908) he cites as settled principles of law uniformly upheld by the courts:

"Particular specimens of the patented inventions can be sold under various restrictions that will bind the purchaser who has notice of the restrictions. In fact, the variety of conditions that can be imposed under a patent is too large to permit a complete enumeration. . . ."

"A certain machine for making a large number of copies of letters is sold under a license printed on the machine requiring that all supplies for use on the machine shall be bought from the makers of the machine."

This is but one of many examples; and, as Mr. Montague shows in our leading article in this number, the law of England is and always has been exactly that laid down again by the United States Supreme Court in the Dick case.

Mr. Montague shows so ably the logic and reason defending what superficially might seem to be unreasonable, that his argument needs no addition. The point to be emphasized is that relations based upon similar provisions extend so widely and so deeply through our existing commercial and manufacturing system that their eradication would be a destructive, even if in other aspects a constructive process. Any amendment is likely to have vastly wider effect on the patent system and industries dependent upon it than the somewhat hasty proposers seem to realize. If amendment is wise and expedient, a most careful examination and deliberation in preparing and adopting it are still wiser and more expedient. This is emphatically a situation where haste should be made slowly.

REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA

MINING LAWS OF THE UNITED STATES

GENERAL FEATURES AND PROPOSED REMEDIES FOR EXISTING DEFECTS

H. V. Winchell—The Engineering and Mining Journal

IN the March number of THE ENGINEERING MAGAZINE, Mr. T. Lane Carter clearly illustrates some of the important advantages in the mining laws of Mexico over those of the United States, especially in regard to the "law of the apex, or extralateral right," in metaliferous districts. The views presented by Mr. H. V. Winchell, of which the following is an abstract, covers also some of the other defects in United States mining laws in general.

The principles underlying the mining laws of various countries have been found susceptible of classification into two groups:

(1) The "concession" system under which the state or a private owner of mining property has the right to grant concessions or leases of such mining property to individuals or corporations at discretion, or under certain general restrictions.

(2) The "claim" system, under which any individual, under certain general specified restrictions, generally as to nationality and color, has the right to locate on discovery or otherwise certain limited areas of ground, and under certain conditions to hold, work and dispose of the same.

Under the concession system the right to grant lies with the owner, and it is said that five-sixths of all

the mining areas of the world are held under it; under the claim system the right to claim mining ground lies with the locator or discoverer. The latter is the system underlying the laws of Canada and the United States as well as South Africa and Australia; but there are fundamental differences in these countries as to the nature of the possessory right and the character of title finally obtained.

The claim system grew out of conditions in early mining days in the United States and Australia. The Argonaut horde which invaded California in 1849 and a few years later rushed to Australia were in many cases allowed to make their own local rules as to size of claim, method of discovery, staking, recording and obtaining title. In the United States the usages thus established were later sanctioned by Congressional enactment which grew into our present system of mining law, and also served to greater or less extent as a model for Australia and other nations.

This system, "however necessary in the peculiar circumstances of its inception, should have been altered as soon as changing circumstances permitted," but instead it has been patched and interpreted by judicial decision until the United States has today the most wretchedly inadequate and antiquated law with which a

great country is anywhere afflicted. Instead of fostering the mining industry the law as it stands today and as interpreted by the judicial and executive branches of the government creates confusion, entails unnecessary expense, causes waste and retards development.

Briefly stated, the United States mining law, known as the Act of 1872, provides for location by discovery; possession perpetuated by annual assessment work; and title in fee simple to the surface and minerals obtained after the expenditure of a certain amount of money by the payment of \$5 per acre, and the observance of certain formalities as to survey, etc. The metal-mining laws do not apply to all of the states. They are made applicable to the Western states and territories with the exception of Michigan, Wisconsin, Minnesota, Missouri, Kansas and Texas.

Mining locations are not recognized in the states east of the Mississippi River, nor is there in any state legal authority permitting one man to prospect or mine beneath the surface of ground owned by another, without the latter's consent. To this statement there is one important exception, and that lies in what is called the "apex law," under which the owner of the outcrop of a vein in mining claims, has the right to follow and mine the vein on its downward course beneath the surface of a claim owned by another. "This law has proven more productive of expensive litigation than of economical mining, and in many of the more recently established and more progressive mining districts has been made inoperative either by common agreement or by compromise between adjoining owners."

Placer mines are likewise located by discovery and held by annual work and acquired by purchase in fee

simple forever. Known veins within placer locations must be declared and paid for separately or else they are excepted from the placer patent and can be located by others in "lode claims." All veins on placer ground not known to exist at the time of application for patent belong to the grantee, but without extralateral or apex rights. If an applicant for a placer patent can be shown to have had knowledge of a valuable lode within his lines prior to the making of his patent application, his title as to that vein may be cancelled for fraud at any time upon application of a contesting locator. There is no limit to the time for such contests and they are still being brought in some cases 20 years after placer patent.

The law is very defective on this point; for it frequently happens that veins discovered today have a value by reason of improved transportation facilities or metallurgical processes, although these same veins were of no value whatever when the placer claim was located and patented. The owner of such a claim is sometimes put to the expense and annoyance of defending such contests repeatedly, since there is no limit to the number of contestants. The law should be amended so as to make it impossible to attack a placer patent on such charges after a reasonable term of years. Another absurd feature of the placer act is that providing for the location of oil, gas, iron ore and other deposits in the same manner as auriferous gravel.

Coal lands are sold by the government upon an appraised valuation, and the amount of land that may be legally acquired is limited for an individual to 160 acres and for an association to 640 acres. Tracts of such limited area do not often justify the installation of the most efficient equipment, and economical operation

is therefore impossible under the terms of the very law which was expressly designed to promote economy and prevent monopoly.

Under the present United States law there is no general system of separation of surface from mineral rights, no leasing of mines from the government, no payment of rental or royalty and no federal supervision or control after location and patent. Taxes are paid to the state and county and mining regulation is attempted by many states. Unfortunately there is no uniformity of principle and practice as to these matters, nor any stability nor assurance of permanence in any state either as to methods of operation required or basis of taxation.

Aside from the generally condemned apex law, there are two or three features of our present system which should be speedily remedied. The first is that provision of the law requiring a discovery of valuable mineral before location. There is really no sense in such a requirement. What seems valuable to one man is often worthless to another; and what is of no value whatever today may be worth a million in a year or two. Moreover it sometimes requires a year's work and a shaft several hundred feet deep before the actual discovery of ore, even though the surface indications give ample promise of its existence below. Every mining engineer and geologist knows that many ore deposits have no value whatever immediately upon the surface of the ground. Why not allow a prospector to stake out his mining claim wherever he chooses on the public domain, and hold it so long as he performs the required amount of development work?

Another defect in our present law is that permitting a prospector to locate an indefinite number of mining

claims and to hold them without actually doing his assessment work. Many promising districts are kept from becoming hives of industry and producers of mineral wealth by the tying up of their territory in this way. The prospector should be restricted in the number of his locations, and real development work should be exacted.

The last important defect in the United States and Alaskan mining and land law is the lack of any provision for appeals to the courts from the decisions of administrative officers. It is contrary to the general spirit of our institutions and an anomaly in constitutional government to take away from any citizen property rights to which he considers himself justly entitled under the law, by the mere fiat of an appointed government official who is here today and gone tomorrow. To place in the hands of such officers the final dicta in matters involving property valued at hundreds of thousands of dollars, and to provide no method of appeal to any duly constituted nonpolitical judicial tribunal is not only to subject the said officials to great and unnecessary tests of moral courage and fidelity, but to require in them the qualifications of superior judges and experience in the interpretation of the law which many of them cannot be expected to possess. Serious injustice may be done without any remedy at law to the defeated applicant. In the interests of justice, provision should be made for appeals in important cases and perhaps in all cases from decisions of the commissioner of the General Land Office or of the Secretary of the Interior to some court of competent standing and jurisdiction, whose decisions could and would be accepted by the public and the interested parties as justified by the law and the evidence.

To counteract the foregoing general defects in the mining laws of the United States, Mr. Winchell proposes the six following recommendations:

(1) The apex law should be abolished.

(2) Mining claims should be locatable regardless of a "discovery" and held only so long as the specified development work is performed in good faith.

(3) Placer locations should be limited to deposits of loose material above solid bedrock.

(4) A statute of limitations

should establish a reasonable term of years beyond which placer patents shall be immune from attack on the ground of misrepresentation in the patent application.

(5) Special statutes should be enacted providing for the location and working of oil, phosphates, rare earths, haloids and other mineral substances not specifically mentioned in the present laws.

(6) Existing titles should be fully recognized and confirmed and no effort should be made to create retro-active legislation.

THE CHEMISTRY OF SEWAGE DISPOSAL

CHEMICAL ACTION THE BASIS OF EVERY SUCCESSFUL METHOD

George G. Nasmith—The Canadian Engineer

IT is now the accepted theory that bacteria and other forms of life are invariably necessary in order to obtain fixed results from any method of sewage disposal. It is recognized that these work under more or less definite, fixed conditions, and demand certain treatment; that they can be governed to perform their functions efficiently, and, finally, in the performance of their work that they depend on a free supply of oxygen to completely oxidize the organic matter and create a non-putrescible effluent.

It came to be recognized that one could obtain all sorts of hydrolytic decomposition in septic tanks, or under anærobic conditions, with productions of proteoses, peptones, amino acids, nitrites, hydrogen sulphide, methane and hydrogen; that these decomposition products were still for the most part putrescible, and sometimes more difficult to handle than the raw material from which they were derived, and that, after all, the complete end products of any method

of decomposition depended on the fact that oxidization of carbon gave carbonic acid; of nitrogen gave nitric acid; of sulphur gave sulphuric acid, and of hydrogen, gave water. These are the final products obtained in any completely oxidized sewage. Sewage disposal in the chemical sense might be stated: Organic matter+Oxygen=Inorganic matter+Humus.

As the object of every method of sewage disposal is to create a non-putrescible effluent, and more recently a non-pathogenic effluent, the anærobic methods, such as that of the septic tank, have failed because of this one fact, that the end products of anærobic action are still putrescible, and must be further treated.

The real biological oxidation methods may be grouped together, since the action taking place in them all is practically the same. These are (1) Intermittent sand filtration, which really is an improvement on the older method of sand filtration; (2) Contact beds—single, double, or triple, and (3) Trickling filters.

In all methods of sewage disposal it is deemed advisable as a preliminary to remove as much of the suspended material as possible, by means of the various forms of sedimentation tanks.

Now, if the material is sterilized in any of these methods, no action, or only a very slight one, takes place. If the sewage is treated with disinfectants, the same thing occurs; but if these various types of beds are given repeated doses of sewage, the organic matter is gradually converted into inorganic salts, and the filter becomes matured. At the same time it is found that the sand granules, or stone, slag, or other material, becomes coated with a gelatinous layer containing bacteria, organic material and iron. As the gelatinous film becomes thicker, the purifying action is improved.

In such a matured, intermittent sand filter, Dunbar found that if a gallon of a solution of albumen was poured on to the top of the filter, a gallon of water, less the albumen, flowed out at the bottom. That this was the same water he proved by adding readily detected chemicals, such as potassium iodide or fluorescein to the original solution. When repeated at intervals he found that the sulphuric acid in the effluent corresponded almost exactly to the sulphur in the albumen, while only part of the nitrogen appeared as nitrate, the rest of the nitrogen disappearing as free nitrogen or remaining locked up in the humus, which was formed in small quantities. A considerable portion of the carbon also disappeared as carbonic acid, while the balance was retained in the humus.

The remarkable fact, therefore, became apparent, that a solution of albumen or sewage may leave an intermittent sand filter thoroughly purified in ten minutes. In other words, the organic material in the sewage

became absorbed by the gelatinous material covering the granules in the filter. It is known from experience that micro-organisms cannot decompose such material in a few minutes.

By excluding air from the filter, it was found that such purification ceased to take place. By sterilization of the bed, or when disinfectants were added to the sewage, purification also ceased. The principle became fixed that bacteria in presence of air were essential for purification.

It was then demonstrated that in a matured contact bed, if quantities of distilled water were added at intervals, there would be considerable quantities of nitrates found in the effluent, and carbonic acid would continue to be given off and found in the air of the filter. The conclusion was therefore very obvious. The organic matter was first absorbed by the gelatinous film, and during the periods of rest while in contact with the air, this was decomposed with the aid of organisms, during which process oxygen was used up, and fresh oxygen drawn into the filter. This latter fact has been proved with the aid of capillary tubes inserted into the beds and connected with monometers. If a contact bed is filled with sewage, and air is blown in at the bottom, the free, unabsorbed oxygen is unable to carry out the necessary oxidizing action, and the sewage is not rendered non-putrescible. The oxygen thus absorbed during intervals of rest seems to be condensed on the surface of the gelatinous film, into some more active form, possibly as ozone, by the high pressure which is known to exist in such gelatinous films.

In the trickling filter, the principle of oxidation has been carried to its logical conclusion. In such beds, the sewage is continuously sprayed over the surface by one of the innumera-

ble devices for the purpose. The bed itself is composed of some hard material, preferably of slag, which does not readily weather, and is so arranged that the filling material becomes smaller towards the top and larger towards the bottom, so that humus-like substances formed may be readily washed away.

Sewages which could not be treated satisfactorily in contact beds were handled satisfactorily by simply trenching the surface of the bed, placing a layer of sand along the bottom of the trench, and allowing the sewage to flow along these trenches, the raised parts allowing free access of oxygen. The contact beds were thus converted into trickling filters, and the results were eminently satisfactory.

The septic tank, which is wrong in principle, except in so far as it may prove useful as a liquefying agent, is already doomed as an integral essential to any method of sewage disposal.

The contact bed, which is on a right principle, wrongly carried out, will also probably soon disappear.

The intermittent sand filtration method, which is satisfactory in principle, is very expensive to construct and maintain for a given unit of sewage treated.

Based on purely theoretical principles, and with the experience already gained, in point of economy and efficiency, there is no doubt but that the trickling filter has come to stay and is bound to displace all present forms.

The sedimentation of the humus-like material from a trickling filter is readily accomplished, and should constitute part of the system in order to obtain a clear effluent suitable for disinfection with chlorine, as well as to remove an obvious physical objection.

The disinfection of raw sewage by chlorine may prove a valuable compromise in some rare instances when other methods of treatment are not possible, but is said to be not working out as well as was expected. It should prove of great value in rendering a clear effluent from biological sewage disposal systems absolutely safe.

THE AIR LIFT PUMP

A STATEMENT OF ITS PRINCIPLES, ADVANTAGES AND DISADVANTAGES

G. J. Davis and C. R. Weidner—Bulletin of the University of Wisconsin

THE term air lift, as applied to the method of pumping, may be best described in the words of Dr. Julius G. Pohle, one of the several inventors who have introduced various modifications into the underlying principles of the operation, as "the processes and apparatus whereby compressed air is delivered in bulk into the lower end of a water education pipe, causing the water and air to ascend through said pipe in alternate layers of definite dimensions."

The basic principles on which the pump works may be described in the following manner: Consider a vertical pipe, open at both ends and partly immersed in a liquid. The liquid will stand at the same height inside and outside the pipe. Assume that a block of light material, cork or wood, fitting snugly into the pipe, but able to move without friction, is made to replace part of the liquid near the bottom of the pipe. The hydrostatic pressure on the underside of the block

is now greater than the combined weight of the block and the liquid above it. The block and the liquid above it will therefore be pushed up in the pipe until the head h balances the difference between the weight of the block and the weight of an equal volume of the liquid. If more blocks be introduced in the same manner, the liquid will be raised a corresponding distance h for each block until both liquid and blocks be discharged from the top of the pipe.

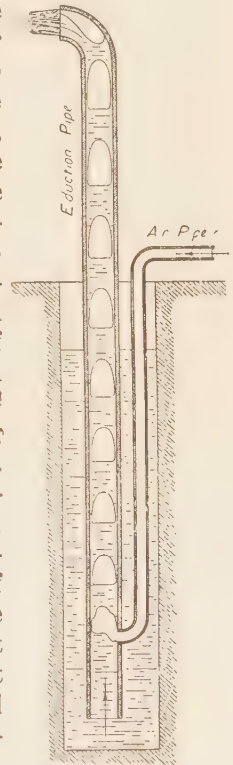
A closer approximation is made to usual working conditions by considering a case in which the block of light material, cork, wood or air, does not entirely fill the cross-section of the pipe. By virtue of its buoyancy it will tend to rise in the pipe, and the liquid will tend to flow down past it, whereby additional head is required to overcome the resistance offered to the liquid in its flow between the block and the pipe walls. This flow of liquid down past the buoyant material is called the slip of the pump, and causes serious losses of energy.

A commonly accepted conception of the principle of operation of the air lift pump may be had by considering that the air bubbles, in rising through the water in the discharge pipe, reduce the specific gravity of the mixture and therefore the weight of the column, causing an unbalanced condition between the column inside and outside the tube. The excess pressure at the base of the column, due to the external water pressure, therefore, forces the mixture above the supply level and out of the top of the pipe. This excess pressure increases with the depth of submergence of the pipe, and the latter must be regulated to suit the height of delivery.

Various attempts have been made to develop a satisfactory theory of the air lift pump based upon a mathematical analysis of the problem, but

it is the opinion of the authors that the most satisfactory one is that presented by Dr. H. Lorenz, in *Zeitschrift des Vereines deutscher Ingenieure*, April 1909, whereby he deduces formulæ which take account of the losses of energy occasioned by slip, pipe friction, etc., and are therefore of practical use in designing air lift pumps.

To start the operation of an air lift pump requires a greater air pressure than is necessary for normal operating conditions. When the air supply is first turned on, the air pressure must be greater than that due to the submergence of the air inlet, while after the discharge of the liquid has commenced the pressure at the air inlet will be reduced by the amount of the entrance and velocity heads of the liquid entering the eduction pipe. To prevent an intermittent action from this condition, the escape of the air into the eduction pipe must be controlled. It should be throttled the instant the discharge of the liquid commences.



THE POHLE SYSTEM

The essential structural features of this pump are extremely simple and few in number. In its simplest form, as illustrated in the accompanying figure, it consists of a pipe for the discharge of the water and a smaller pipe for conveying compressed air to it at a point near its lower end.

The eduction pipe should not touch the bottom of the well or reservoir, but should be elevated so as to freely admit the liquid through its lower end. The intake end should be submerged a greater distance below than the outlet end is above the surface of the liquid, for most efficient operation.

In most air lift pumps the compressed air from the air pipe enters the eduction pipe through a casting designed to cause the air to enter in a special manner. The casting used for such a purpose is technically called a foot-piece. Changes in the form of the foot-piece have little, if any, effect on the efficiency or capacity of the pump, other than the effect due to the amount of obstruction of the water passages; a factor which differs in the various types.

The most serious disadvantage in the operation of these pumps is the low hydraulic efficiency. While the pump is generally credited with efficiencies of only 25 to 33 per cent, yet in some cases the entire pumping plant develops a duty comparing favorably with other pumping systems.

The field of a single air lift pump is limited principally to deep well pumping, owing to the high percentage of submergence required to give good efficiencies. This limiting field can be counteracted to some extent by the use of multiple stage installations, although probably at the cost of decreased efficiency.

The liquid pumped cannot be carried to any horizontal distance from the well, unless provision be made at the top of the vertical eduction pipe for the discharge of air.

The principal claim to superiority lies in its large capacity. When the conditions are suitable for its installation, an air lift pump will discharge more liquid from a well of small bore than will any other type of pump.

This is due to the fact that almost the entire cross-sectional area of the well is available for the flow of liquid and the action is nearly continuous. The quantity that can be discharged by an air lift pump is only limited by the capacity of the well and the expense of pumping at unreasonably high rates; while deep well pumps, the majority of which are single acting, limit the discharge by the allowable piston speed, which usually does not exceed 100 feet per minute.

Owing to the simplicity of the pump the expense of maintenance of the plant is very low, and is due principally to the expenses in connection with the compressor. The operation of the air lift is exceedingly simple and the life of the pump is almost indefinite. The fact that there are absolutely no moving parts in the well makes the pump especially fitted for handling dirty or gritty water, sewage, mine water and acid or alkaline solutions in chemical or metallurgical works, or other corrosive liquids. Liquids that attack metals such as brine, sulphuric acid, etc., may be pumped by the air lift pump, because the pump and appurtenances may be replaced at a small expense and loss of time. The application of the air lift as a dredge pump has been tried and found successful, but it has not been extensively used for this purpose.

Where the water is to be used for a domestic supply and there are impurities in it such as iron, it has been noticed that the iron is oxidized by the aeration of the water and the supply is thereby improved. Aeration is especially advantageous in the pumping of sewage on account of the aid it gives in the oxidation of the impurities.

Air lift pumps are not liable to sudden stoppages or breakdowns.

STRIKE LEGISLATION

REVIEWS OF THE LAWS OF THE BRITISH DOMINIONS AND OTHER COUNTRIES

Engineering

ELSEWHERE in this magazine will be found a paper by Dr. James Douglas in which is illustrated the methods employed by a great iron master, Sir David Dale, in the arbitration and settlement of labour disagreements; also an article by John B. C. Kershaw presenting views on the leading causes productive of such labour disputes with suggestions for their elimination. In connection therewith and in view of the recent coal strikes, the following abstract from an editorial in *Engineering*, based upon a volume prepared by the Labour Department of the Board of Trade, reviewing legislative methods in effect in countries other than Great Britain, should be of particular interest.

The form taken by the legislation of various countries connected with lock-outs and strikes of all sorts varies immensely. It ranges, on the one hand, from complete prohibition, to the prohibition of such actions merely during any official attempt to bring about a settlement of the dispute. Nine European countries have legislation designed to avoid strikes of employees engaged in public utility services, and of these, five absolutely prohibit such workers to strike. In three other European countries strikes are illegal unless regulations requiring notice, etc., are complied with. In other countries the limitations imposed on strikers merely relate to the completion of a task in hand, but in others strikes are indirectly rendered impossible in public services owing to the attitude of the Government to-

wards unions and similar organisations.

The public utility services are, in a general sense, supposed to include water supply, electric and gas lighting, means of public locomotion and communication, etc. It seems rather strange, in these days of hygienic propaganda, that, with one exception, no specific reference, so far as we can find, is made so as to include sanitation within the term.

So far as British dominions are concerned, legislation has gone furthest in Australasia. Each of the various States comprised in the Commonwealth and the Dominion of New Zealand has its own laws; and, in addition, since federation, a Commonwealth law has likewise been brought into being having reference to disputes which affect more than one State. Such disputes, if it be in the public interest to do so, are to be settled by a Court which has power to make an award. For the purpose of enforcing such awards, penalties may be inflicted, and these may be executed against the property of an organisation. If the funds of the organisation are insufficient, individual members may be proceeded against.

In Western Australia an Act providing for the settlement of disputes by conciliation and arbitration is in force. Under it, it is illegal to bring about a strike or lock-out. Inciting to strike is illegal, and trade-union officials have been sentenced in this connection to fines of as much as 50*l*. The New South Wales legislation provides for the settlement of disputes in various industries, and especially

is intended to cover the conditions relating to workers connected with the supply of "necessary commodities." Meetings for the purpose of instigating or managing a strike or lock-out are illegal, and persons taking part in them are liable to twelve months' imprisonment.

New Zealand has, perhaps, had more legislation of this kind than other countries. The reference of industrial disputes to councils of conciliation is obligatory. The Government railway servants are dealt with as an organised union by the Minister of Railways. Workers who are party to a strike while an industrial agreement affecting them is in force are each liable to a fine of 10*l.*, and employers who are party to a lock-out are, under similar circumstances, liable to a fine of 500*l.* Outside persons instigating a strike are liable to fines of 200*l.* Special penalties of a rather heavier rate are imposed in the case of strikes connected with certain specified industries, the interruption of which would cause public inconvenience. It appears that 80 per cent. of the fines inflicted on strikers and employers have been collected in New Zealand.

In Canada legislation partakes of an altogether different character. It makes provision for the appointment of a Committee of Conciliation in case of a "difference" likely to lead to a strike. The Committee is appointed by the Minister for Labour, on his own motion, or at the request of a municipality affected. The Committee has power to investigate and report publicly. Strikes, pending reference to a committee or during investigation, are illegal. This legislation now refers to railways, the mining industry, etc. Penalties are inflicted for going on strike or locking-out, or inciting to either during these proceedings. Prosecutions have been instituted under these Acts. In some

cases employers have been fined for lock-outs, in others union officials for inciting to strike.

In the United States, generally speaking, the individual States recognise the right to strike, and picketing, so long as it remains of a peaceful character, is not interfered with. Intimidation, however, is illegal. The railway employees do not come merely under State regulation. When serving corporations engaged in inter-State business, they are under the supervision of the Federal authorities.

In Russia peacefully conducted strikes are no longer punishable, except those connected with Government services or public utilities. They are forbidden in the railway, telegraph, and other services, and strikers, or persons inciting to strike, are liable to imprisonment. Intimidation is also discountenanced and punished in like manner. Agricultural labourers guilty of striking are also liable to imprisonment. In Denmark there is a permanent arbitration court and a Government conciliator; to act in violation of an award or agreement is illegal.

In Germany the right to strike exists, but does not extend to municipal undertakings, such as gas and water supply, nor to railways, etc. Freedom to work is provided for. As regards the State employees, the ability to strike is practically withdrawn by the strictness with which surveillance is conducted with regard to industrial unions. Membership is strictly forbidden of any union which is deemed to be working in a direction inimical to the interests of the State. The official oath is supposed to have been violated in the case of such a man, and he would be dismissed from the service.

In Austria the public services are protected by controlling the formation of the unions. The formation of

a union is not sanctioned if its aims are thought to be dangerous to the State. An organisation of this type would be dissolved and its funds seized. In that country railway employees have enforced their demands by complying strictly to the letter with all rules governing the service and operation, thereby delaying traffic intentionally. This action is now regarded as a breach of the official oath no less serious than striking.

The right of employees in the public services in Italy to strike is also withheld, but by adopting methods similar to those just referred to in the case of Austria the employees on the railways have obtained some of their demands. Soldier labour can be used in Italy if need be, and universal service enables the Government to meet the needs of the public in case of extreme emergency under prolonged strike.

REGENERATIVE STOVES IN BLAST FURNACE PRACTICE

A. N. Diehl—*The Engineers' Society of Western Pennsylvania*

ONE of the most important epochs in the history of the blast furnace, and in the manufacture of pig iron, was the introduction of the so-called hot blast or regenerative stove. The principle was first applied by Neilson in 1828, for the purpose of preheating the air before conducting it through the blast main into the hearth. Iron pipes were first employed for carrying the blast from the blowing engines, but only comparatively low temperatures, about 900 degrees, could be obtained in this manner, and also the pipes deteriorated very rapidly, causing a considerable up-keep expense.

The application of heated blast was directly responsible for a decrease in fuel consumption per ton of iron to about one-half that of the cold blast. This was undoubtedly due to the increased affinity of incandescent coke for the oxygen of the air under the conditions of higher blast temperatures. In modern practice it is considered that an increase of 100 degrees in the blast will decrease the coke consumption, per ton of iron, by 50 to 60 pounds. Above 1,300 or 1,400 degrees, however, the saving becomes less, as the point is ap-

proached where the gas becomes less reducing.

About the year 1860, fire brick stoves replaced the former construction. These were further developed by various stages, until at present the stoves are built 22 or 23 feet in diameter and 100 to 110 feet in height, with 60,000 or more square feet of heating surface, and withstanding blast pressures which frequently reach 30 pounds.

There are two main classes of stoves; center combustion and side combustion chamber. The center combustion stove may be either of the two-pass or three-pass type; the side combustion stove appearing in either the two-pass or four-pass type. In all types the gas is allowed to enter the combustion chamber through a gas burner, where it is consumed, the products of combustion passing through the checker to the stack. The air for combustion may be either mixed in the burner or passed through air doors into the combustion chamber where it is consumed at as low a point as possible.

The combustion chamber is common to all types and is built up of first grade fire brick. The channels of

flues at the bottom of the stove should be so constructed as to pull equally on all checkers, and maintain a uniform and equal draft throughout the whole stove area. The location of the stack on the center combustion three-pass stove is directly on top of the dome, and serves to pull evenly over the stove area. In the center combustion two-pass stove a uniform draft may be accomplished by means of a flue constructed directly beneath the combustion chamber in the center of the stove, having small converging flues leading to it from the checker work, and in turn leading directly to the stack. In the side combustion stove this equal draft is attained, in many cases, by double flues leading to the stack, as in the Morrison-Kennedy construction.

A blast furnace will produce about 150,000 to 160,000 cubic feet of gas per ton of iron, 10 per cent of which may be assumed as loss; one-third of the remainder will be burned in the stoves for the preheating of the blast, while the remaining two-thirds can be divided for power purposes and used at the boilers or for driving internal combustion engines. The gas as it leaves the furnace contains a considerable quantity of dust, some of which is deposited in the dust catcher and mains, and the remainder carried on to the point of gas consumption.

At the Duquesne Blast Furnace of the Carnegie Steel Company, the gas is washed through spraying tower washers, where it is at present cooled from 350 degrees to five or six degrees above the temperature of the washing water, and the dust removed to an average of about 0.2 of a grain per cubic foot. Formerly the ingoing water had an average temperature of 55 degrees, and the temperature of the outgoing gas, 72.3 degrees, or a difference of 17.3 degrees. The scrubbers have been since re-designed, and

now there is a difference of only five degrees between the water and the outgoing gas. The results are obtained with the same water consumption per minute and a greater gas volume.

About 30,000 cubic feet of gas are passed through each 12-ft. scrubber per minute, where it is repeatedly sprayed by means of a cut-off valve having a revolving core, the water spraying through nozzles and is broken up so as to bring it into very intimate contact with the gas. That this contact is attained, is evident by the close temperature of the gas to the entering cooling water. There are 815 gallons of water per minute used in each tower. The average since January 1, 1911, is 35 cubic feet of gas per gallon of water. There is some dirt deposited in the clean gas main, especially at such points where the main makes a bend, and these points must be cleaned out from time to time. If the gas is insufficiently cooled, it will pick up moisture to such an extent as to make it incombustible. In some cases, on a number of stove tests which have been run, the efficiency of the clean gas stoves is about 8 per cent. higher than that of the dirty gas.

A comparison of stove equipments in the different plants shows a decided lack of uniformity in regard to heating surface required for different size furnaces. As an illustration, there are two modern plants, each having furnace bosh diameter of 22 feet with 134,000 and 223,000 square feet of heating surface respectively. Both furnaces should be capable of the same tonnage production.

Firebrick is a poor conductor of heat, therefore the exposed area, or heating surface, should be as large as possible. The volume of brick work must be strong enough, however, to withstand all the strains to which it will

be subjected. It is evident that with a consumption of 5,000 cubic feet of gas per minute a heating surface area too small would allow extremely high stack temperatures. This would introduce a loss which would not be present in case there was sufficient heating surface, yet at times, in order to get a high temperature in the stoves, this quantity of gas may be required.

Efficient burning of the fuel gas may be accomplished by proper proportioning of the burner, which should be such that the gas and combustion air shall be thoroughly mixed and the ratio of gas to air such that combustion of all constituent gases will proceed easily. The average blast furnace gas requires about 0.7 cubic feet of free air for perfect combustion. This, however, does not allow for any variation and in practice should be carried to the proportions of about one to one. The air excess in this case will be slight and the loss in heat would be small, while sufficient oxygen is practically assured to meet all requirements in fluctuation of the constituents. It must be borne in mind that if dirty gas is used in the burner in the theoretical proportions, there is great danger of fusing the brick in the combustion chamber at the point of flame impingement. Heavy flue dirt clinker is also liable to form in the combustion well, clogging it up.

Draft should be symmetrical and uniform over the full area of the stove and the stack should be so placed and its communication to the stove should be such that this will be the effect. The ill effects of not having it are many and may include: Local clogging in the regions where the draft is intensified; high velocity of combustion products with its consequent reduction of time contact and heating surface, intensified local tem-

peratures productive of glazing, vitrification, unequal expansion and contraction; highly heated surfaces confined to a comparatively small area and ultimately shifting the seat of operation to another point when resistance in the original path has become too great.

The superimposed stacks, those finding application in stoves of the three-pass type, seem to have eliminated the difficulty of obtaining symmetrical draft, although having the disadvantages attributable to the resultant cooling during the period the stove is on the furnace. The ills above cited are particularly pronounced in the two-pass center combustion chamber, where communication to the stack is so effected as not to be conducive to symmetry in draft.

Stack temperatures are dependent: First, upon the extent of heating surface; second, absorptive power and mass of brickwork; third, time contact, which is determined by the intensity of draft; fourth, the volume of the recuperative gases; and fifth, the blast. The time required by a unit volume of regenerative gases in passing through the stove will be considerably more than that required by the blast, the volume ratios of blast to heating gases averaging about four or five to one in the most approved practice. The item of stack temperature is one of the most important entering into stove operations and its influence upon the economies to be realized, not only on account of the enormous heat losses represented by abnormally high temperatures, but the deleterious effect upon chimney valves and seats where these are not water cooled. Heat losses in flue gases have been noted, constituting as high as 35 to 36 per cent. of the total heat entering the stove in the fuel gas, which added to other losses encountered will often run up to 50 or

55 per cent. of the total heat made available to the stove.

The tendency to conservation and the rapid increase in the cost of coal, consequently coke, has resulted in accentuating effort in the economical and efficient consumption of blast furnace gas. Consequently furnacemen have turned their attention to hot blast stove construction and the economical importance of its proper

design, together with a conscientious regard for the quality of material that shall enter into its construction; all of which have a direct bearing upon the value and efficient consumption of fuel gases. Considerable attention has also been directed to the cleaning of gas as a means of economy in stove practice, a number of plants having extensive washing systems in operation.

ALTERNATING CURRENT ON SHIPBOARD

SAVINGS EFFECTED IN THE LIGHTING AND WIRING SYSTEM ON BATTLESHIPS

Lieut. A. Norris—American Society of Naval Engineers

IN proposing an alternating-current installation for a battleship it has been attempted to meet, as far as practicable, all the requirements of power and lighting as are now demanded by the electrical specifications for vessels of the Navy.

A voltage of 230, 60-cycle, three-phase, will be used for the generators, and 220 volts for the power receivers. This drop of voltage between generator and receiver will conform to present specifications as regards line drop.

The use of the higher voltage is in line with good commercial practice and gives a saving in weight and cost of material. Any prejudice against the increased voltage would seem to be the result of conservatism on the part of the service at large. Similar voltages have been used on naval vessels abroad for some years, and this should tend to allay any fear of liability to dangerous shock in the handling of this higher potential.

The electrical system aboard ship is a combined lighting and power system, and consequently the same frequency would have to be used for both purposes. Twenty-five cycles would be the best for motors, but

such a frequency is too low for lighting purposes, so 60 cycles has been chosen, in accordance with the best commercial practice. The heating requirements are much more severe than in regular commercial practice, and as a result the greater part of the electrical machinery on board ship must be of special design.

The generating plant as designed for a modern battleship consists of four 300-kilowatt generators, direct-current, multipolar, compound-wound, to run at a constant speed of 1,500 revolutions per minute, and to deliver 125 volts at the terminals at rated speed with load varying between no load and one and one-third rated load.

In place of this plant it is proposed to substitute the following turbo-generators; three 500-k.v.a. units, alternating-current, three-phase, sixty-cycle, 3,600 revolutions per minute. The increased output of the plant is necessary in order to allow for the assumed power factor of .80.

For the field excitation of these generators there will be required two 45-kilowatt, 125-volt, direct-current, turbo-generators. One of these machines is sufficient for the excitation

of the fields of the three generators at full load, the second machine being installed as an emergency precaution. The exciters are shunt wound and the field excitation is to be controlled by a Tirrill regulator so as to obtain constant terminal voltage of the main generators.

The total saving in weight in favor of the alternating-current installation is 10,000 pounds.

On comparison with the direct-current water rate there is found a saving of 23.5 per cent. in water consumption over the direct-current installation. This gain for the alternating-current installation is due to the increased efficiency of the generator and to the greater economy of the high-speed turbine.

The present direct-current installation requires frequent overhauling of the commutators. In the alternating current installation this trouble is eliminated except in the small exciter sets. This is an appreciable advantage, as it is well-known fact that the failing of the commutator under heavy overloads has been the cause of the loss of many generators when their services have been most needed.

Overload conditions of the generator plant are frequent aboard ship. These conditions can be handled far more satisfactorily and with less danger by the alternating-current generator than by the present direct-current machine.

The manipulation of the alternating-current switchboard in alternating-current parallel operation requires better training and more attention on part of the personnel, but the units themselves require much less attention in operation and upkeep.

The present lighting wiring is on the two-wire system operating on 125 volts at the distribution boards.

In the alternating-current system it is the intention to use the same system both as to distribution and as to voltage. To carry out this scheme of lighting it is proposed to use two three-phase transformers on the lighting system to reduce the generator voltage down to 125 volts at the distribution boards. The battle-load and cruising-load wiring will be run on the two-wire system as at present, but so distributed from the distribution boards that approximately one-third of the load will be taken by each phase. This will practically balance the lighting load on the generators; any unbalancing will be very small and of no consequence.

Recently the tungsten lamp has come into extensive use commercially, and recent tests of this lamp on board ship have been very satisfactory. This lamp has a much higher efficiency than the carbon-filament lamp now in use and lasts as long. The current consumed by the tungsten lamp is 1.20 watts per candle against 3.5 watts per candle for the carbon-filament lamp.

From a table of weights and costs of wiring as computed for a recent battleship it is found that the weight of copper in the lighting system is approximately 10,000 pounds, mains, feeders and bus bars, costing about \$4,500.00. Computing the same for the exclusive use of tungsten lamps a very conservative estimate places the weight of copper at 6,000 pounds and the cost at \$3,500.00, a saving in weight of 4,800 pounds and in cost of \$1,000.00.

In the alternating-current system all power appliances are supplied with 220-volt, three-phase, sixty-cycle current. The voltage regulation remains the same as in the direct-current installation.

From the table of power wiring, bus bars, feeders and mains computed

for the new battleships it is found that the weight of copper is approximately 25,000 pounds and will cost about \$10,000.00. If the proposed alternating-current wiring were substituted the weight will be reduced to about 10,000 pounds and the cost to about \$5,000.00, a saving in weight of about 15,000 pounds, which is sixty per cent. of the weight of the present installation, and in cost of about \$5,000.00, which is fifty per cent. of the total cost.

The alternating-current searchlight is considered in Germany to be superior to the direct-current light. If the alternating-current should ever be placed on naval ships it is recom-

mended that such searchlights be installed as being much more economical, since proper voltage could be obtained from the power mains by the use of a step-down transformer.

In concluding it may be said that the alternating-current system on a battleship presents the following advantages over the present direct-current system: (1) Greater reliability. (2) Decreased weight, approximately 25 per cent. (3) Increased economy of operation, about 23 per cent. (4) Decreased first cost, about 20 per cent. (5) Decreased cost of maintenance. (6) Better voltage regulation. (7) Less attendance required. (8) Absence of electrolysis.

FRENCH MILITARY AVIATION

THE ORGANIZATION OF AN AERONAUTICAL SERVICE BY THE GOVERNMENT

Lieut. B. H. Barrington-Kennett—Royal United Service Institution

IT is obvious that the army which can obtain the mastery of the air in time of warfare, is going to hold a very real advantage over its adversary. The training of a vast quantity of pilots and officers is necessary to attain this end; machines can be turned out at a very rapid rate by the French manufacturers, but the adequate training of a crew to operate the machines is a matter of many months.

The whole country to a man supports the Government in its determination to keep France far ahead of all other countries in aviation; the enthusiasm displayed throughout the country is wonderful, as is evidenced by the fact that quite small boys in the streets know all the particulars about machines of the best known makes, and rarely make a mistake in naming an aeroplane flying over their heads at a height of 1,000 feet or more.

Early in 1910 the Government adopted the following organization and appointed officers to the various posts:—

(a) An Inspector General of Aeronautics.

(b) Staff:—1 dirigible pilot officer and 2 aeroplane pilot officers.

(c) Executive:—Divided into three sections with a colonel and staff to each section. The duties of the three sections, are:—

(1) Instruction of pupils for pilot certificates; training of dirigible crews; and distribution of pilots among the various aeroplane camps.

(2) Purchase of machines, engines and parts, and distribution of same.

(3) Experiments and tests of all kinds in connection with aeronautics.

The officers of the aeronautical service are drawn from all branches of the service. Non-commissioned officers and men—mechanicians, carpenters, etc.—are sappers, specially se-

lected for the work after passing an examination. French officers say that this organization works well, as it affords scope for specializing.

At present the army possesses three medium-sized dirigibles for instructional purposes, and one small and two large ones for service work. It is the general view among the officers that large dirigibles are not adapted to military service, and that small ones are only useful in co-operation with the larger type of aeroplanes for reconnaissance work, especially at night.

There are about 200 aeroplanes in the service, of which 120 are single seated, and 80 passenger carriers. Opinion seems to be about divided among the officers as to the relative advantages of the biplane or monoplane types. Comparatively speaking, the biplanes are easier to learn on, easier to land with and afford the better view; whereas the monoplanes are faster, more stable in a wind, and more easily assembled and dismantled.

Of the machines now being provided by the Government, the single-seated monoplanes are to be at the immediate disposal of the commander of a force; to be dispatched by him to obtain any particular piece of information which the pilot will communicate to the commander in person; to observe the effect of artillery fire; and to locate the position of the enemy's batteries, supports, reserves, etc. These will require a very experienced pilot-observer. The two-seated biplanes and monoplanes are for reconnaissance of a more or less definite character; for work in conjunction with the cavalry, and will carry the pilot and a trained observer. The three-seated biplanes and monoplanes are for more extended reconnaissance of an indefinite nature; for destroying airships, aeroplane camps, etc.; as an

engine of offence during engagements, and will carry the pilot, an aid-pilot or mechanic and an observer.

With very few exceptions all the military pilots are officers, the idea being that so long as there is a very considerable element of risk in aviation, the proper position for an officer in a two or three-seated machine is the pilot's seat. The pilots of the single seaters must necessarily be officers, owing to the twofold duty of piloting and observing. It is foreseen, however, that it will not be possible to provide a sufficient number of officer pilots for the very large number of machines that will be required. Consequently the French are now beginning to train a proportion of non-commissioned officers and men.

France possesses quite a number of first-rate pilots who have done their period of service in the army, and again others who have yet to serve, and who, on joining, would be fully qualified to fly Government machines. On mobilization there will be ample scope for civilian pilots to lend their services to the State; this they are one and all most willing and anxious to do.

After obtaining an ordinary Aero Club certificate (2 flights of 5 figures-of-8 each, landing within 50 yards of a given mark with engine stopped, and attaining a height of 165 feet) an officer is provided with a machine. It is then his ambition to obtain the advanced military certificate, which, besides 3 flights of 60 kilometers ($37\frac{1}{2}$ miles) at a height of 500 metres (1,650 feet), entails the passing of a practical examination in map-reading, and in the mechanism of his aeroplane and engine. This latter test is particularly desirable, as without doubt every officer pilot should be in a position to act as his own mechanic.

During the manœuvres last autumn the majority of observers were staff-

officers who volunteered for the duty. It is realized, however, that it will be necessary on mobilization to have regular officer observers, who have been trained and noted down as such. If this is not done, on the outbreak of hostilities a large number of officers from the staff and various regiments, batteries and so on will have to be hastily told off as observers, thus seriously interfering with the whole system of discipline and organization. One ideal condition is for

the Aeronautical Corps to be self-contained, *i.e.*, for every officer in it to be trained both as a pilot and as an observer. It is thought, however, that this is not practicable, as the qualifications for the two duties are so very different, though it is true that there are officers, such as Conneau ("Beaumont"—the winner of nearly all the big cross-country flights last year), who excel at both duties. Such are the men who in war time will pilot the single seaters.

TRAFFIC AND TOLLS ON THE PANAMA CANAL

A RESUME OF THE STUDIES SUBMITTED BY EMORY R. JOHNSON TO THE
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE OF
THE HOUSE OF REPRESENTATIVES

Engineering Record

THE construction work of the Panama Canal is now rapidly approaching completion, and since all the direct financial return from this enormously expensive undertaking must depend upon its revenue-producing capacity, it is quite evident that the present session of Congress will find the problem of fixing the tolls to be one of considerable magnitude.

In the first place, the problem is not merely one of tolls, but is influenced by many other things which must be kept in mind before fully appreciating the task. For instance, tolls are levied on the tonnage of vessels, and there are various ways of determining tonnage. The net tonnage of the "Kentuckian" by the United States rules is 4,116, by the British rules 4,085, and by the Suez rules 4,875. It is apparent, therefore, that the total sum to be paid by the vessel passing through the canal will depend upon the system of measurement followed. Most vessels which will use the canal will be of British

registry, and they would naturally be favored by permitting them to use the canal without another measurement. It is possible, however, that British and American systems of registration may be revised and unified, as their present differences are slight.

The study of the traffic which the canal may be expected to carry brings out features of our commerce not generally understood. Examinations of statistics indicate that in 1899 the world's commerce which could have used the canal advantageously would have required the movement of 5,000,000 net registered tons of shipping. Corresponding statistics for the year ending June 30, 1910, show an available tonnage for the Panama Canal route of 8,328,000 tons. That is to say, the growth has been at the rate of 59 per cent in ten years. It has been found that the growth in commerce through the Suez Canal has been about 70 per cent in a decade, while that of twenty-two leading nations increased 58.4 per cent in a decade. Consequently it is

assumed that a development of 59 per cent every ten years is at least reasonable to expect for the Panama Canal route.

From information furnished by owners of vessels of different types and different speeds, it has been ascertained that it costs about 10 cents per day per net registered ton to keep a vessel on the sea. If such a saving per day can be made, it seems that for all points on the west side of North and South America, north of a point 1,500 miles south of Panama, the canal has an absolute monopoly of the traffic and the volume of that traffic will be affected in no wise by any toll which is likely to be imposed. South of the lower limit of that zone for a distance of 1,000 miles the canal has a monopoly of the traffic so far as the Atlantic and Gulf seaboards of the United States are concerned, but in traffic from Europe the toll may become an important factor in determining what route ships shall take. This is important because in this thousand miles of the west coast of South America are the nitrate fields, from which about 2,500,000 cargo tons are now shipped annually. Valparaiso and the agricultural portion of Chile are on the boundary of the competitive zone, where the tolls will determine whether a ship goes through the canal or the Straits of Magellan. So far as the Atlantic and Gulf seaboards of this country are concerned a toll of fair proportions may be imposed and still allow vessels to pass through the canal to engage in commerce across the Pacific, but the toll must be low if the canal is to secure any appreciable portion of European commerce in the Orient.

Another item affecting the choice of routes is the location of supplies of coal. The ability to secure coal at short intervals en route enables the

shipmaster to minimize bunker space and to use a maximum share of the ship's capacity for paying cargo. Since the United States must have a large coaling station on the Isthmus for the use of the Navy anyway, an enlargement to meet the demands of trading vessels would not be an unwise undertaking, and would attract additional traffic to this route.

The cost of coal and the tolls are by no means so important as paying cargo. It is for this reason that Professor Johnson has assumed that 10 per cent of the commerce between Australia and Europe will find it advantageous to use the Panama Canal. Often the most profitable route between the ports of departure and ultimate destination is a circuitous one, which will permit cargo to be loaded and discharged at more intermediate ports than can be reached by a direct route. For instance, the short route from Japan to the eastern seaboard of the United States will be by way of the Panama Canal and vessels sailing from Yokohama with full or nearly full cargoes will unquestionably take the Panama route. It is the vessels leaving Australia for Europe partly loaded or in ballast which will contribute most of the tonnage of shipping using the Panama Canal between these two termini.

It is self-evident that the tolls which will permit one group of the world's traffic movements to use the canal may bar out another group. For the traffic between the Atlantic-Gulf seaboard of this country and the west coast of South America, except that concerned with Patagonian wool, Dr. Johnson estimates that a toll of \$1 per ton net register will not have any restraining influence on the use of the canal. For the traffic between Europe and points on the west coast of South America from 1,500 to 2,500 miles south of Panama, a toll of more

than \$1 would divert shipping from the canal, and for places in the agricultural district of Chile more than 2,500 miles south of Panama any toll above 75 cents would send ships through the Straits of Magellan. The traffic between our eastern seaboard and Australia will mostly use the canal if the toll is fixed at \$1, and some of it, particularly that with New Zealand, might stand a higher rate without being diverted from Panama. It is estimated that no outbound ships from Europe to Australia would use the canal, but about one-tenth of those returning may use the canal, depending on tolls, coal, insurance rates, cargoes and other causes. The traffic between Europe and New Zealand will be largely affected by the Panama tolls; at \$1 a large part of the traffic in chartered vessels will move by way of the Straits of Magellan, while traffic by regular lines will incline toward the canal, although any toll above 75 cents will be favorable to the Suez route. It is certain, however, that a toll not exceeding 5 or 6 per cent of the average freight charge will render the canal an attractive route.

Dr. Johnson believes that the United States cannot divert by means of low tolls at Panama a large tonnage from the Suez to the American route. But he considers that it will be desirable to make the Panama tolls

lower than those at Suez, and to sell coal at attractive prices at Panama in order to insure bringing to the canal the major share of the commerce between our Atlantic seaports and Asiatic ports from Singapore to Yokohama. At the present time the Suez toll on loaded vessels is about \$1.55 per net ton, British measurement, and \$1 on vessels in ballast, but the Suez company is very prosperous and its rates may be reduced in the future if the business is materially affected.

The first few years of operation will teach many things and the Government should be in a position to apply its lessons immediately, in order that we may put the great work on a secure financial basis as quickly as possible, so as to be free from the necessity of applying any of our national revenues to canal expenses. This purpose, which is desirable from every point of view, is best served by placing in the hands of the President the power to adjust tolls between certain limits and to make such regulations regarding registration, operation and general management as he may see fit. Such powers will enable the President to bring to the service of the canal not only a trained staff of competent men, but will also give him the power to utilize the services and advice of those men to the best advantage of the country.

RAIL SPECIFICATIONS

TEST CONDITIONS AS IMPOSED BY THE VARIOUS ENGINEERING ASSOCIATIONS

W. C. Cushing—Railway Age Gazette

IN 1895, at Zurich, Switzerland, the International Association for Testing Material was organized to bring about "the development and unification of standard methods of testing, for the determination of the properties of materials

of construction, and of other materials, and also the perfection of apparatus for that purpose." On June 16, 1898, there was formed, at Philadelphia, the American section of the International Association, which, a few years later, was renamed The

American Society for Testing Materials. The American section was composed of manufacturers as well as of consulting engineers, railway engineers and others, and had already begun the study of rail specifications. Therefore, at its annual convention in 1901, the rail committee of the American Railway Engineering Association submitted the rail specifications recommended by the American branch of the International Association for discussion, in order to get the subject under way.

Specifications for steel rails have always consisted of three general parts:

1. Chemical requirements of properties;
2. Physical requirements; and
3. Details of manufacture.

Up to that time the various railways emphasised one or more of these parts, according to their individual preference or experience. Some almost ignored the chemical requirements, others were more or less elaborate in their physical requirements, while some barely touched upon details of manufacture, and others treated the subject quite elaborately.

The chemical properties of those proposed specifications for bessemer steel rails were those of the Carnegie Steel Company, and they are today the standard chemical specifications of all the steel manufacturers, and of the American Society for Testing Materials, with scarcely any alterations. These were as follows: Rails, 50 to 60 pounds; carbon, 0.35 to 0.45; manganese, 0.70 to 1.00. 60 to 70 pounds; carbon, 0.38 to 0.48; manganese, 0.70 to 1.00. 70 to 80 pounds; carbon, 0.40 to 0.50; manganese, 0.75 to 1.05. 80 to 90 pounds; carbon, 0.43 to 0.53; manganese, 0.80 to 1.10. 90 to 100 pounds; carbon, 0.45 to 0.55; manganese, 0.80 to 1.10.

In rails of any weight the phosphorous was not to exceed 0.10, and silicon not to exceed 0.20. Specifications for foreign use were practically the same.

The only changes which have been made in these specifications by the steel manufacturers and by the American Society for Testing Materials up to the present time, are to make the carbon for 60 to 70-pound rail .5 to .45, and the manganese for 90 to 100-pound rail .84 to 1.14.

With few exceptions, the railways of the United States have accepted these chemical constituents as recommended by the rail manufacturers, because they have considered that the chemical properties were only a minor part of the specifications for rail steel, compared with the physical requirements.

Two general methods for testing the physical requirements had been in use up to the year 1900, viz., a bending test of a small bar $\frac{1}{2}$ inch to $\frac{3}{4}$ inch square and 10 inches to 20 inches long, and a drop test which consisted in letting fall a weight of about 2,000 pounds on a piece of rail with a span of 3 to 4 feet. Some railways used one method, some the other, and some both, but by 1900 the small bar test had been generally abandoned in favor of the drop test.

It was customary to make a test of every fifth heat of steel, and to let the weight fall distances varying from 16 feet on light rail up to 19 feet on the heaviest sections. These conditions were not accepted by the American Railway Engineering Association, as there was a strong feeling among the railway engineers that more severe conditions of testing were necessary. They felt that the chemical properties could be left to the greater experience and chemical knowledge of the rail manufactu-

rers, but that they must be the ones to prescribe the physical tests which the finished rails must stand in order to be accepted for such important service as carrying the railway traffic of the country. In 1904, therefore, the engineering association decided that each heat, instead of every fifth heat of steel, must be tested, and that the height of the drop should be increased.

It was also ascertained that the rail butts heretofore tested under the falling weight had been from the bottom of the ingot, and it was now made a part of the specifications that the test piece should be taken from the top of the ingot, on account of the probability that the metal would be less perfect at that end than at any other point.

Testing every heat instead of every fifth heat, as formerly, was considered little short of a revolution in the method of testing at that time.

Lately there has been a great deal of argument on the part of the rail manufacturers to have the railway engineers specify a definite percentage of discard from the ingot, in order to cut off material which is more subject to segregation and more liable to have interior defects from the shrinkage cavity, gas bubbles, etc., but the railway engineers have rigidly set their faces against such a requirement, because they feel that they are much better safeguarded by the clause introduced into specifications of the American branch of the International Association for Testing Materials, which was that "sufficient material should be discarded from the top of the ingots to insure sound rails."

The railway engineers of today are unanimously agreed upon this point, and their position has been further strengthened by an additional test by the adoption of a test for

the discovery and elimination of the so-called "piped rails," or rails with interior defects. Furthermore the records of the rail failures which have been kept for a number of years disclose the fact that, where a 15 per cent discard might do for one ingot, 50 per cent would not be adequate for another.

On April 25, 1906, a committee on standard rail and wheel sections was appointed by the American Railway Association, and on October 24, 1906, the committee was directed to report in addition on the subject of specifications for the manufacture of steel rails, in connection with its report on standard rail sections.

A final report was submitted by the committee on April 22, 1908, with the recommendation that there were many details of the development and the following up of the results of the new types of sections in service, rolled under the new specifications, which would require considerable time and much careful study, and that they could be more efficiently and more appropriately handled by the American Railway Engineering Association.

On the subject of discards, the report also contained the following statement:

"In order to avoid the unnecessary waste of good material, the committee set about to devise means by which the rejection of defective material could be insured without requiring an arbitrary and definite percentage of discard in every case, and a committee of the Pennsylvania Railroad, pursuing the same line of investigation, adopted a tentative specification which provided for a physical test of this nature, and which further provided that when physical defects were discovered all top rails of the heat should be rejected. This would result in a dis-

card of about 25 per cent. to 30 per cent. of the entire metal in the heat whenever physical defects were discovered, and it was felt that a requirement of this nature would not only provide for the rejection of defective material, but would insure the greatest care on the part of the manufacturer.

The new rail designs of the Pennsylvania and the American Railway Association provided for a more even distribution of the metal in the head, web and base and for a thicker base, to meet the views of the rail manufacturers, who believe that a better distribution of the metal would result in an improved quality, due to more favorable rolling conditions. All of these sections are still in service and are being closely watched to determine whether the expected improvement will be realized.

While at the present time the American Railway Engineering Association has not adopted standard specifications for rails, yet it has had constantly before it for consideration and study a set of proposed specifications which have embodied

the best knowledge of the subject, and they have been changed from time to time in the light of new experimental investigation. The most energy has been devoted to the improvement of methods of testing to determine the physical properties, and practically no changes have been made in the chemical requirements from the standard specifications of the rail manufacturers. The railway engineers prefer to subject the finished material to such tests as will cast aside the defective rails. Their specifications, therefore, include many additional tests over those in use ten years ago. The results of the work of the American Railway Engineering Association have been closely followed by the railway companies and *vice versa*, so that the specifications of the railways have been improved from time to time, and now embody the additional tests devised. Rails have been rolled in accordance with these new specifications for several years, and it is believed that a marked improvement is apparent in the rails being laid in the tracks since their adoption.

THE SHERARDIZING PROCESS

GALVANIZING BY THE FORMATION OF ZINC-IRON ALLOY

Thomas Liggett—The Foundry

IN the course of some extensive experiments for the purpose of improving case-hardening methods, early in the twentieth century, Dr. Sherard Cowper-Cowles sprinkled some zinc dust on a piece of steel and subjected the whole to the ordinary case-hardening process and at a temperature less than the melting point of zinc—less than 788 degrees Fahrenheit. When the material cooled, he found that the steel was coated with a thin layer of zinc.

After thorough and exhaustive tests it was found that this coating gave the underlying metal better protection than that obtained by the well known hot process.

The essential apparatus necessary in a sherardizing plant is an oven large enough to receive the retorts or drums which contain the material to be treated. The largest retorts in use today have been installed by the Mark Manufacturing Company of Chicago, which are 26 inches in di-

ameter and 23 feet long, designed for merchant pipe. The retorts are loaded with the material to be treated and zinc dust or dross, placed in the oven and subjected to the heat from any of the common fuels, providing that an even temperature may be maintained. The retorts are left in the oven for a short period at a constant temperature and then removed. When they can be handled, they are opened and the material and unused dust are dumped on a screen or grating. The dust falls through and is ready to be used again. The material is finished and found to be covered with a continuous, uniform coating of zinc iron alloy, with a very thin coating of metallic zinc on the surface. No matter how irregular is the shape of the material, it has a uniform coating and everything is reproduced, which is not the case with either hot or electro-galvanizing. In electro-galvanizing the hollow places are not coated, and with hot galvanizing, threads and holes are filled and flaws covered. An inconsiderable amount of superficial material is added by the sherardizing process. The zinc dust which is used in the process is a secondary product from a zinc smelter and is recovered in the flues. The dust is composed of from 85 to 92 per cent metallic zinc, about 7 per cent zinc oxide and some other impurities which are not in sufficient quantities to work any injury. Zinc dross also can be used instead of dust and it has its advantages. It is the material which settles to the bottom of a galvanizing kettle. After treating it, no difficulty is found in pulverizing it for use.

While there have been several theories advanced as to the action which takes place in the retorts or drums during the process, yet the following facts alone are known:

If metallic zinc content in the dust is kept constant there is on the same class of materials equal weights of coating, under the same temperature and time of treatment.

Zinc does not begin to deposit until the material has reached the temperature at which magnetic oxide of iron appears.

Iron which oxidizes with difficulty, sherardizes with difficulty.

The continuity of the zinc dust coating, when properly applied, is equal to and in the majority of cases superior to the hot galvanized coating. While, it is true, under the microscope the zinc iron alloy shows cracks or fissures, these are of such minute dimensions that nothing can get through to the underlying metal. The adherence of this alloy is very tenacious. The durability of the alloy coating is great, although it is a little more brittle than pure zinc and has a slight tendency to flake if bent through a sharp angle. The metal which is exposed after the flaking is still resistant to corrosion, which shows that the underlying metal is not exposed. The resistance of the alloy to corrosive agencies is much greater than with the zinc coatings. Sherardized, hot galvanized and electro-galvanized articles were subjected to a 20 per cent solution of sulphuric acid. The hot galvanized and sherardized samples had the same weight coating and the electro-galvanized were somewhat lighter. The results of the tests showed that, although the sherardized coating has more iron in it than the hot galvanized, it will resist corrosion over three times as long as an equal coating of hot galvanizing.

In testing sherardized material the method most frequently used is the Preece or copper sulphate method. This consists of immersing a piece of galvanized material in a standard

copper sulphate solution for one minute, then washing in clear water and drying with cotton waste. This is repeated four times and if there are no bright metallic copper deposits, the material is accepted. The standard solution is one whose specific gravity at 65 degrees Fahrenheit is 1.186. It is prepared by dissolving copper sulphate in water, to which an excess of cupric oxide has been added. This solution is then filtered and the specific gravity made 1.186 at 65 degrees Fahrenheit.

The trouble of testing sherardized material by this method is that if the material is wiped with waste a burnishing action takes place. The reasons for this are that the sherardized coating being an alloy, the copper is deposited more slowly and is more adherent than that which deposits on hot galvanized material; as the sherardized surface is rough it affords a foothold for this copper and the waste rubbing the top burnishes the copper so that instead of cleaning the surface as the specifications intend, the deposit is rubbed onto the object. With further dipping, the copper deposit thickens, and those not thoroughly familiar with this action will decide that the

coating has failed. To overcome this, it is always best to use a stiff bristle brush and scrub lightly instead of using waste.

The alloy coating dissolves slower in the standard copper sulphate solution than either hot or electro galvanizing. It has been found that the sherardized or zinc iron alloy coating loses 0.005 ounces per square foot per dip; hot galvanized 0.068 ounces per square foot per dip, and electro-galvanized articles 0.067 ounces per square foot per dip. This is another evidence that a sherardized coating will withstand corrosion better than either hot or electro-galvanizing of equal weight.

The sherardizing process is particularly well adapted for treating castings. As previously mentioned, the surface of the casting is exactly reproduced. As the heat is applied slowly and the material is cooled slowly, all strains are relieved and the operation serves to anneal the casting. This is in contrast to the treatment the material is given in the hot process, which crystalizes about 85 per cent of material treated, due to raising the temperature of the castings so suddenly and then cooling at about the same speed.

REFRACTORY BUILDING MATERIAL

A NEW NON-COMBUSTIBLE WOOD SUBSTITUTE FOR BUILDING PURPOSES

Charles L. Norton—Journal American Society of Mechanical Engineers

IT is clear that in order to be accepted as a substitute for wood in building construction, a new material must approximate in lightness, strength, elasticity and ease of working, the natural woods, and further, since the variation in natural woods fits them for special details of construction, the substitute must be had in different grades of

hardness, toughness, fineness of texture, etc. Moreover the ease of working, sawing, boring, nailing and so on, leads to a wide use of natural wood, and a substitute to be acceptable must approximate the ordinary woods in these respects.

Many of the earlier attempts were made in the direction of altering the natural wood by some chemical

treatment, so as to make it ignite with greater difficulty and burn more slowly and without much flame. These processes afforded a number of so-called fire-proof woods. The principle underlying the chemical treatment was usually one of two. First, the wood was saturated with a solution, which, on drying, left in the pores a salt capable of giving off a gas when heated, this gas being of such a nature as to be incapable of supporting combustion. Phosphate of ammonia and tungstate of soda were extensively used for this purpose. With thorough saturation the protection afforded the wood and adjoining portions of the structure was by no means insignificant; specimens of wood treated with phosphate of soda have been in the possession of the author for more than ten years, and after ten yearly tests show no signs of deterioration. Similarly some specimens of wood and cloth treated with tungstate of soda in 1903 have shown little or no loss in fire resistance. The main value of such chemical protection lies in its diminishing the volume of the resulting flames. When once thoroughly ignited, the fireproof wood burns more briskly than the natural untreated wood.

The second method of chemical treatment was one in which such substances as alum were used in order to supply a considerable quantity of steam from the water of crystallization and also to encase the pores of cells with a solid refractory substance.

There have been from time to time, in the last 30 years, attempts to make use of boards composed only of refractory, inorganic substances. In general, such boards have been composed of some fiber and a cementing medium. The most popular fibres for this sort of experimenta-

tion have been asbestos and mineral wool, the cements used including about all the common cements of both the air drying and the hydraulic types. Oxychloride of magnesium, the value of which as a cement was discovered some 50 years ago by Sorel, has been the favorite cement for experimenters because of its simple preparation, its quick hardening and great strength. For some reason, however, a large percentage of the oxychloride cement is variable in its properties and often defective. When mixed with sand or similar dense bodies the oxychloride is often satisfactory for long periods, but the experience of the author with mixtures of this cement with fibers, both organic and inorganic, leads to the conclusion that it is unstable and unsatisfactory. This is more probably the case when the boards are used in damp places or out of doors.

After much study two conclusions seemed inevitable to the author: First, no homogeneous inorganic substance was likely to prove satisfactory, but that a mixture of a fiber and a cementing substance was necessary to give wood characteristics to the material; and, secondly, a mixture of asbestos fiber with one or two cements (first, oxide of magnesium or calcined magnesia, and, second, calcium silicate and aluminate mixture) seemed more suitable than any other combination.

From these conclusions the author proceeded to develop a material, under certain processes of mixing, pressing and curing, which he calls asbestos wood. He claims that it is practically incombustible, harder than natural woods, has a transverse strength about two-thirds that of white pine with the grain, and, without being brittle, an elasticity less than that of natural woods; the coefficient of thermal conductivity has

been found in English units to be between 50 and 30 per square foot per 24 hours, per 1 degree Fahrenheit.

The weight of the several grades of asbestos wood 1 inch thick varies from 8 to 13 pounds per square foot. White pine 1 inch thick when dry weighs approximately 3 pounds per square foot, and oak about twice as much. The transverse strength of boards and the minimum fiber stress is between the limits of 5,000 and 10,000 pounds. Test specimens 12 inches wide, 12 inches long and $\frac{1}{4}$ inch thick, broken by center load when supported on two edges with 11 inch span, broke on an average at 200 pounds load. Under the same conditions clear white pine broke under a load of 300 pounds with grain and 20 pounds across it. In some cases the equality of strength in both directions is of great advantage.

The tendency of the material to absorb water varies between the limits of 4 per cent and 20 per cent. This absorption is not of such a nature or amount as to cause disintegration from freezing and the material is not injured by prolonged soaking in fresh water. Sea water tends to disintegrate it after a time, the magnesium salts in the water replacing the calcium of the cement.

The coefficient of expansion varies with the temperature and also with the age of the specimen. It is small, being about 0.000004 at ordinary temperatures, diminishing rapidly at 700 degrees Fahrenheit, and becoming negative at 950 degrees Fahrenheit where shrinkage occurs.

The operations of boring, sawing and finishing are all somewhat more difficult with asbestos wood than with the natural woods. It withstands scraping and rubbing much better. Floors and stair treads made of the

material wear well, but are liable to be slippery when wet.

Its ability to stand heat makes it available for blocks on friction brakes where a flexible material is not needed. The coefficient of friction of iron is approximately 0.3 to 0.4.

It has also been used as a mold for glass utensils during the process of manufacture, its non-conducting properties making it preferable to iron in some instances.

It is, of course, the fire resistance of the asbestos wood which gives it its greatest interest. There is nothing combustible in it, and on exposure to fire nothing can occur except a gradual dehydration of both fiber and cement. Under prolonged red heat the boards become weakened, but for such exposure as occurs in fires in buildings the resistance is ample. For instance, a sheet of $\frac{1}{4}$ -inch asbestos wood may be placed over the top of an open furnace at 1700 degrees Fahrenheit, the flame impinging directly on the lower surface of the sheet, and at the end of half an hour the sheet may be taken off and while its lower side is still white hot be plunged into cold water and then returned to the furnace for 10 minutes. It may be slightly warped and its strength will probably be diminished 25 per cent or more, but it will still be sound and whole and free from cracks or serious weakness. Fire tests have shown the ability of the material to withstand much longer exposure, but it is not suitable for linings for furnaces or kilns which are kept constantly at red heat. In some fire tests the paint on the outside of an asbestos wood door $1\frac{1}{4}$ inches thick was not scorched after the fire inside had been burning at a temperature of 1700 degrees Fahrenheit for more than an hour.

OXY-ACETYLENE WELDING

METHODS FOR THE PRODUCTION AND USE OF ACETYLENE AND OXYGEN

H. R. Cobleigh—*Journal American Society of Mechanical Engineers*

OF the different kind of torch or blowpipe welding, the two of the greatest present commercial importance are oxy-hydrogen and oxy-acetylene. Air gas and oxy-gas (coal gas) torches are also used, but they do not give as high temperatures as either oxy-hydrogen or oxy-acetylene torches and are generally considered not well adapted either to welding or cutting, but useful mainly for soldering and brazing.

The oxy-hydrogen process, although older than the oxy-acetylene process, has not been developed quite as rapidly, although for certain applications it has the advantage of its competitor. For all purposes where the greater heat intensity of the oxy-acetylene torch is of no advantage, the oxy-hydrogen torch with its temperature of about 4000 degrees Fahrenheit is as good or even better. Another advantage is that it makes use of a by-product of electrolytic decomposition of water, one of the best methods of procuring the purest oxygen, and a process that is becoming of important commercial significance for making oxygen for the acetylene torch as well. Further, the hydrogen can safely be compressed directly into tanks for carrying on outside operations or supplying any portable outfits, whereas acetylene must be dissolved in acetone to be handled safely when compressed above two atmospheres.

The ideal arrangement would seem to be the providing of all three gases, oxygen, hydrogen and acetylene, in plants of a size to warrant it, employing apparatus for the electrolytic production of the first two gases

and an acetylene generator, and using the oxy-hydrogen and the oxy-acetylene torches on the work for which each is the best adapted. There is a sufficient overlap in the profitable applications of each to introduce no difficulty in the proper relative consumption of the several gases. One of the oxy-acetylene torch manufacturers, the Davis-Bournonville Company, is arranging to manufacture oxy-hydrogen apparatus, appreciating the value of their correlated use.

What are commonly spoken of as low-pressure and high-pressure torches are better classified as injector and pressure, or positive-mixture types, as this is the chief distinction, indicating the manner in which the acetylene is taken in. In the injector torch the oxygen admitted under pressure draws in the acetylene after the familiar action of a steam injector, and by the law governing the action the quantity drawn in depends on the square of velocity of the oxygen jet.

Le Chatelier has the credit of having first called attention to the high temperature obtainable in the combustion of acetylene with oxygen. This was in 1895. The discovery was not taken advantage of until 1901, when Fouché and Picard brought out a torch in which they diluted the acetylene to prevent back flashing. The following year they overcame the necessity of dilution by employing a high-pressure torch which emitted the gases at such a velocity that the flame could not strike back. This, however, was difficult to use because it blew the metal away as fast as it was melted. In 1903 Fouché introduced the low-

pressure torch still familiar as such, in which the oxygen only is under appreciable pressure and the acetylene is drawn in by injector action.

The pressure-type torch introduces both gases under pressure and the proportion of the mixture can be varied by varying either pressure. The pressures on the gases, never over a few pounds, will depend on the size of the torch, which in turn is determined by the character of the work and the size of flame needed. These torches must either be supplied with dissolved acetylene or from a pressure generator, whereas the injector torches can take their supply from an ordinary lighting generator.

In the use of the torch it is very important to maintain a neutral flame, that is, one having neither an excess of acetylene nor of oxygen, as the first would carbonize the work and the second oxidize it. The proper condition of the flame is easily determined by observation, and the gases can be regulated accordingly. With an excess of acetylene there will be two inner cones, one extending beyond the other and less luminous. By reducing the acetylene pressure the second cone will recede and when it finally coincides with the first, or disappears, the flame is neutral.

Commercial carbide yields from $4\frac{1}{2}$ to 5 cubic feet of acetylene per pound. Lump carbide in sizes of $1\frac{3}{4}$ by $\frac{3}{8}$ inch, known as "nut," is claimed to yield from 5 to 15 per cent more acetylene than finely divided carbide, probably due to more or less slaking of the latter by moisture in the air. For that reason generators capable of using the lump carbide claim a certain advantage over those limited to the use of the crushed form.

Two kinds of generators are used, known, from their manner of feeding, as water-feed or "water-to-carbide"

generators and carbide-feed or "carbide-to-water" generators. The first is very little used because of the disadvantage that the apparatus gets very hot and the gas is not likely to be so good.

Where the reverse manner of feeding is used and the carbide is dropped into the water, the gas is washed as it is evolved and it and the apparatus kept cool. In these generators it is well also to have an abundant supply of water in the bottom. The generally accepted rule now is a gallon of water to each pound of carbide to be used.

Where a generator is carried on a portable outfit the water-to-carbide type is probably the safest, since a carbide-feed type would be more likely to generate gas when jarred. Some argue that a generator should never be carried on a portable outfit, but that compressed gas tanks should be used. This calls for the explanation that whenever compressed acetylene is spoken of what is meant is dissolved acetylene, for the gas becomes very explosive when compressed to above two atmospheres. In 1896, Claude and Hesse, two French engineers, discovered that acetone is a remarkable solvent for acetylene. For each atmosphere of pressure it will dissolve 25 times its own volume of acetylene, and in this condition the latter is not explosive under heavy pressure. The acetone is placed in tanks containing porous material so that there are no spaces for the gas to separate and collect in, and the acetylene is compressed into them. Acetylene in this form, although costing twice as much as when generated, is very convenient in outside repair work where portability is a feature.

Of all hydrocarbons, with the possible exception of liquid and Blau gas, acetylene possesses the greatest

proportion of carbon, 92.3 per cent, the remaining 7.7 per cent being hydrogen. It is therefore most nearly gaseous carbon, for there is no means of obtaining a high enough temperature to gasify pure carbon. It gives about five times as much heat per cubic foot as hydrogen and a flame of greater intensity, the temperature being, as has been mentioned before, 6300 degrees Fahrenheit.

Oxygen generation is of three classes, chemical, electrolytic and atmospheric, to each of which except the second there are subdivisions.

The most common chemical process is by dry evolution under the influence of heat from a mixture of 100 parts by weight of crystallized chlorate of potash and 13 parts of manganese dioxide, contained in a sealed retort. After washing in caustic soda to eliminate chlorine, the gas can be compressed in a two-stage compressor, or else generated under pressure by using heavier retorts and heating longer or more intensely. With all processes using manganese dioxide precautions are necessary for obtaining pure oxide, as carbon or hydrocarbons in any form, even traces of oil from a compressor, which should therefore not have cylinder lubrication, must be eliminated before compressing the oxygen on account of their combustibility.

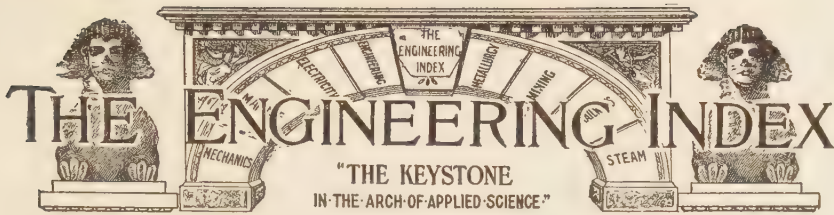
The purer the oxygen the better, as even small percentages of impurities decrease the economy and the strength of the welds. Oxygen produced by the electrolytic process is 99 per cent pure, the only impurity being a trace of hydrogen.

Atmospheric oxygen is next in purity to electrolytic, its only impurity being nitrogen. The process used by the Linde Air Products Company at its various works from which it dis-

tributes for sale the gas compressed in tanks, consists first in the complete liquefaction of the air to be resolved by a process of accumulative cooling. The liquid thus formed is then submitted to a process of rectification at the same time that an almost complete transference of heat is obtained from the compressed air entering the apparatus to the liquid air thus formed. In this way 95 or 96 per cent pure oxygen can be obtained.

An important device between the torch and the source of the gas, whether oxygen, acetylene or hydrogen, and whether from pipe line, generator or tank, is the pressure regulator, for with all torches it is necessary to maintain constant pressures to secure uniform work. Regulators vary somewhat according to the gas, and in minor details in different makes. The function of the regulator is that of a reducing valve to maintain any set constant pressure not exceeding that of the source, and there is always combined with it a pressure gage on the discharge side to show the pressure admitted to the torch. Where the gas is taken from portable cylinders an additional gage is provided on the other side of the regulator to show the state of depletion of the compressed gas in the cylinder.

With flame welding nearly all kinds of metals can be welded, cast or wrought iron, steel, brass, aluminum, copper, etc. Skill and experience count for much and many things originally thought impossible are now being quite readily accomplished. A consistent study of materials and their composition and structure has led to the overcoming of many difficulties. The behavior of metals under the influence of heat, particularly their expansion and contraction, requires study and allowances in making welds.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

- | | |
|--|--------------------------|
| (1) The title of the article, | (4) Its length in words, |
| (2) The name of its author, | (5) Where published, |
| (3) A descriptive abstract, | (6) When published, |
| (7) <i>We supply the article itself, if desired.</i> | |

 The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes’ time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one’s special interest.

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CIVIL ENGINEERING

BRIDGES

Bascules

Bascule Bridge Over Harbor Channel at Copenhagen. C. Van Langendonck. Illustrated description of the structure and its erection. 800 w. Ry Age Gaz—March 8, 1912. No. 31102.

The New Four-Track Rolling Bascule across the Schie at Delfshaven (De nieuwe rolbasculebrug voor vier sporen over de Delfshavensche Schie). N. M. de Kanter and J. E. van der Burg. Description of the bridge itself and its operation by electrical mechanism. Ills. 3600 w. De Ingenieur—Mar. 2, 1912. No. 31383 D.

Cantilevers

Cantilever Bridge Built by Siwash Indians. Illustrated description of an interesting old bridge over Bulkley Canyon in British Columbia. 900 w. Ry & Engng Rev—March 16, 1912. No. 31223.

Culverts

Methods of Making Culvert Extensions in Widening Roadbed, New York Central & Hudson River R. R. Charles E. Anderson. Drawings and description of work made necessary in carrying out four-tracking operations for improved roadbed conditions. 1600 w. Engng & Con—March 6, 1912. No. 31067.

We supply copies of these articles. See page 325.

Highway

The Calculation of Web Members of Iron Half-Parabola Street Bridges (Beitrag zur Berechnung der Gurte des Halbparabelträgers einer eisernen Strassenbrücke). W. Schulz. Formulas adopted and tabulated results. Plate. Serial. 1st part. 1600 w. Elektrotechnische Rundschau—Feb. 15, 1912. No. 31377 D.

Lift Bridges

Lift Bridges on the New Haven Railroad. R. W. Eaton. Illustrated description of the two draw-bridges of the Scherzer rolling lift type. 1200 w. Elec Jour—March, 1912. No. 31601.

Reinforced Concrete

Method and Cost of Constructing a Reinforced Concrete Road Bridge. C. A. Bingham. A new bridge in Cumberland Co., Penn., is described. Ills. 700 w. Engng & Con—March 27, 1912. No. 31624.

Concrete Highway Bridges. George H. Herrold. Read before the Minn. Engrs. Soc. Considers reinforced concrete bridge building. 1200 w. Cement—Feb., 1912. No. 31498 C.

The Central Avenue Bridge at Rochester, N. Y. Illustrated description of a reinforced concrete structure combined with a concrete dam and head-works for power development built under unusual conditions. 2000 w. Eng Rec—March 2, 1912. No. 30984.

Reinforced Concrete Bridge at Farnworth. Illustrations, with brief description of a bridge on the Kahn system, built over the Cheshire Lines Ry. 500 w. Engng—March 1, 1912. No. 31146 A.

A Concrete Bridge at Kansas City. Illustrated description of an artistic reinforced-concrete bridge over Brush Creek, and its construction. 1200 w. Cement Age—March, 1912. No. 31457.

The Reinforced-Concrete Bridge at Tempe, Ariz. Illustrates and describes details in the construction of a bridge across the Salt River. 1200 w. Eng News—March 28, 1912. No. 31629.

Reinforced Concrete Bridges with Overhead Arches (Ponti in cemento armato ad arcate superiori). Plans and illustrations of several constructions. Serial. 1st part. 3000 w. Il Cemento—Feb. 29, 1912. No. 31412 D.

See also Viaducts, under *Bridges*.

Steel

Erecting 110-ft. Plate-Girders with a Long-Reach Derrick Car. E. A. Gibbs. Illustrated description of erection methods used on an extension of the W. Maryland Ry. 1500 w. Eng News—March 21, 1912. No. 31469.

Bridge Construction on the Oregon Trunk Railway. Illustrates and describes steel structures unusual in design and method of erection. 2000 w. Ry Age Gaz—March 29, 1912. No. 31637.

The Bridge over the Lys (Pont sur la Lys). A. Vierendeel. Calculations and

formulae used in the design of this 44.4 meter steel bridge. Ills. 7000 w. Alliance Industrielle—Mar., 1912. No. 31415 D.

Viaducts

Reinforced-Concrete Viaduct Carrying a Seattle Street over Railway Yards. E. E. Adams. Illustrates and describes work done by the Great Northern Ry. 2500 w. Eng News—March 21, 1912. No. 31465.

The Fifth Street Viaduct at Fitchburg, Mass. Illustrated description of a reinforced concrete structure with deck arch spans of about 32 to 76 feet and a 204-foot through arch span. 1500 w. Eng Rec—March 9, 1912. No. 31086.

CONSTRUCTION**Beams**

Historic Notes on Metallic Beams and Girders. R. B. Woodworth. Aims to show the steps passed in the evolution of beam and girder design. Ills. 24500 w. Pro Engrs' Soc of W Penn—Feb., 1912. No. 31444 D.

See also Columns and Reinforced Concrete Beams, under *Construction*.

Buildings

Reinforced Concrete Construction of the Munich Market (Die Eisenbetonkonstruktionen der Grossmarkthalle in München). B. Rueb and A. Keller. Giving the calculations for bracing projections, and other details. Ills. and plans. 3800 w. Beton u Eisen—Feb. 26, 1912. No. 31354 E.

The Church of St. Magdalen, Strasburg, Alsace (Die Magdalenenkirche in Strassburg i. Els.). E. Conrad. Details of the construction of a reinforced concrete church. Ills. 2700 w. Beton u Eisen—Feb. 26, 1912. No. 31350 E.

Building Remodeling

Shoring and Remodeling the Front of a New York Building. Describes methods used in reconstructing the façade of a building made necessary by a municipal ordinance. 1200 w. Eng Rec—March 16, 1912. No. 31219.

Caissons

See Foundations, under *Construction*.

Cement-Gun

Properties of Hand Mixed and Cement-Gun Mortars. A report of comparative tests and results. 1500 w. Eng Rec—March 9, 1912. No. 31088.

Cofferdams

General Methods of Difficult Cofferdam Construction at Koochiching Falls Power Development, Minnesota. H. C. Ash. Read before the Minn. Surv. & Engrs. Soc. (Condensed). Describes novel methods. Ills. 3000 w. Engng & Con—March 13, 1912. No. 31176.

Columns

Some Notes on Column Design. F. Tissington. Urges the use of a standard series of curves, and explains why he adopted Prof. Fidler's formula. 1000 w. Can Engr—March 21, 1912. No. 31473.

Concrete

Proposed Rules for the Measurement of Concrete Construction. A committee report before the Nat. Assn. of Cement Users. 2000 w. Eng News—March 28, 1912. No. 31628.

Finishing Concrete Surfaces. Jerome Cochran. Gives suggested methods for treatment. 7500 w. Cornell Civ Engr—March, 1912. No. 31593 C.

Methods of Patching and Repairing Concrete. Conclusions drawn from an investigation of current practice made by a committee of the Am. Ry. Engng. Assn. 1200 w. Eng Rec—March 30, 1912. No. 31657.

Concrete Work on the Fourth Avenue Subway. Samuel M. Purdy. Describes briefly the principal features of the concrete work incidental to the construction. 4000 w. Cornell Civ Engr—March, 1912. No. 31591 C.

See also Contracts, Lavatories and Waterproofing, under *Construction*; and Concrete, under *Materials of Construction*.

Contracts

Instructions to Bidders on Contracts. Jerome Cochran. Presents a standard for checking up the completeness of general clauses. 13000 w. Eng News—March 7, 1912. No. 31079.

Competition in Public Contracts. Cassius E. Gillette. Suggests principles that should be made law to prevent contract graft. Also discussions. 30000 w. Jour Am Soc of Engng & Con—Feb., 1912. No. 31653 C.

Clauses as to Concrete and Ferro-Concrete. Editorial discussion of the need of special attention to these clauses in contracts. 2500 w. Engng—Feb. 23, 1912. No. 31039 A.

Electric Power

Electricity in Building Construction. Illustrates and describes electrically driven machines for this work, explaining their advantages. 5500 w. Elec Rev & W Elect'n—March 2, 1912. No. 30978.

Estimating

Prime Costing and Estimating. G. James Wells. Considers the aim, and when it is justified, and discusses system. 5000 w. Manchester Assn of Engrs—March 9, 1912. No. 31523 N.

Excavation

Motor Trucks for Hauling Blasted Rock from City Aqueduct Tunnel, New York. Illustrates and describes methods adopted for the hauling of over a million yards of rock from a big city. 1200 w. Eng Rec—March 30, 1912. No. 31659.

Expansive Forces

Forces of Expansion and Contraction. Edward Ingham. Shows how these factors are provided for in design. 2000 w. Power—March 12, 1912. No. 31120.

Failures

The Failure of the Spang-Chalfant Reinforced-Concrete Building, Pittsburg,

Penn. Illustrated account of this failure on Feb. 19, 1912, at Etna, a suburb of Pittsburg. 1800 w. Eng News—Feb. 29, 1912. No. 30943.

Fireproof

Inside Story of Equitable Building Fire. Illustrations and description of what was seen in a brief survey after the fire. 1500 w. Ins Engng—Feb., 1912. No. 31434 C.

Fire Protection

Concrete Water Barrels for Trestle Protection. Hunter McDonald. Read before the Engng. Assn. of the South. Discusses the essentials necessary to secure efficient service. Ills. 1200 w. Eng Rec—March 2, 1912. No. 30985.

Fire Prevention and Public Safety. Rudolph P. Miller. A brief of the New York State Factory Investigating Commission. Arguments applying more especially to the city of New York and conditions found there. 8500 w. Ins Engng—Feb., 1912. No. 31435 C.

Floors

Experimental Study of Stresses in Flat Slabs. Frank J. Trelease. From a paper before the Nat. Assn. of Cement Users. Describes experiments. Ills. 2000 w. Eng Rec—March 30, 1912. No. 31663.

Difficult Floor Renewal in a Tannery. Describes work in Newark, N. J., including the driving 25-foot piles where the headway was limited to 16 feet. 1200 w. Eng Rec—March 23, 1912. No. 31485.

Foundations

Pneumatic Caisson Foundations for Tall Buildings. Alex. Allaire. Illustrated detailed description of pneumatic caisson work for carrying the piers of buildings to rock. 4000 w. Can Soc of Civ Engrs—Dec. 7, 1911. No. 31293 N.

Cylinder Foundation in Ferro-Concrete. Illustrated description of the building and sinking of a large ferro-concrete caisson. 800 w. Engng—Feb. 23, 1912. No. 31035 A.

Heavy Power-House Foundations. Illustrated description of the main features of foundations for the Pendleton station of the Cincinnati Traction Co. 1200 w. Eng Rec—March 2, 1912. No. 30986.

Joints

Strength of Glued Joints. L. V. Ludy. Reports a series of tests and results. 1000 w. Wis Engr—March, 1912. No. 31576 C.

Dovetailing and Gluing-Machine. Illustrated description of a machine used in joining wood so as to produce the strongest possible board with economy of labor. Especially used in making "Torroba" boxes but applicable to other work. 1000 w. Engng—Feb. 23, 1912. No. 31042 A.

Lavatories

Concrete Construction in the Underground Public Lavatories in Charlottenburg (Betonkonstruktionen der unterirdischen Bedürfnisanstalten in Charlotten-

burg). Herr Zangemeister. Details of construction. Ills. 3300 w. Beton u Eisen—Feb. 26, 1912. No. 31351 E.

Piling

The Scantlings of Reinforced-Concrete Piles. Frank H. Jeffree. Considers the stages which a pile passes through before its use in required work and their influence on scantling. 1000 w. Engng—March 15, 1912. No. 31525 A.

Retaining Walls

Graphic Determination of Pressures on Retaining Walls. J. A. Main. Describes a simple method, found useful, that can be applied to any type of wall. 1500 w. Engr, Lond—March 1, 1912. No. 31151 A.

A Concrete Retaining Wall Failure. An illustrated account of a massive wall pushed over by the impact of filling dropped some 30 or 40 ft. into place. 1800 w. Eng News—Feb. 29, 1912. No. 30938.

Rivetting

Diagram for Determining the Pitch of Rivets in Plate Girders. Edward C. Dilworth. Gives diagram and explanation of its use. 500 w. Eng News—March 21, 1912. No. 31472.

Tables for the Strength of One-Line Rivet Connections under Eccentric Load. E. L. Wood. Gives tables with explanation. 600 w. Eng News—March 21, 1912. No. 31471.

See also Rivets, under MECHANICAL ENGINEERING, *Materials of Construction*.

Roofs

The Reinforced Concrete Roof on the Municipal Granary at Osthafen in Berlin (Das Eisenbetondach des Städtischen speichers am Osthafen in Berlin). Details of roof construction. Ills. and plate. 1700 w. Beton u Eisen—Feb. 26, 1912. No. 31353 E.

Sand Drying

The New Sand-Drying Plant of the United Railways Company of St. Louis. C. L. Hawkins. Illustrated detailed description. 2000 w. Jour Assn of Engng Soc—Feb., 1912. No. 31193 C.

Shops

Unit Concrete Shop Construction. Illustrated description of a new erecting shop at Worcester, Mass. 1500 w. Am Mach—March 14, 1912. No. 31128.

Silos

The Economics of Silo Construction of Permanent Materials (Concrete and Clay Tile); Construction Methods and Costs. M. L. King. This first article of a series considers the contracting problem, silo essentials and silo materials. Ills. 1600 w. Engng & Con—March 6, 1912. Serial. 1st part. No. 31065.

The Calculation of Side and Bottom Pressures in Silos According to the Experiments of T. Bienert (Zur Berechnung der Boden- und Seitendrucke in Silos auf Grund der Versuche von T. Bienert). A. S. Oesterreicher. Formulas and tables for such determinations. 2400 w. Zeitschr

des Ver deutscher Ing—Feb. 24, 1912. No. 31363 D.

Specifications

The Writing of Specifications. H. P. Breitenbach. Explains the comparative method of writing specifications. 4000 w. Eng News—March 7, 1912. No. 31080.

Steelwork

Approximate Design in Structural Steelwork. George A. Merrill. Explains the author's method of estimating at short notice, particularly in regard to steelwork for office buildings and warehouses. 1600 w. Eng News—March 21, 1912. No. 31470.

Steelwork in Hotel McAlpin, New York. Illustrated description of deep girders with double and triple webs in foundation and superstructure. 2000 w. Eng Rec—March 30, 1912. No. 31661.

Tunnels

The Large Tunnel beneath the Elbe (Il grande tunnel sotto l'Elba). Description of the construction difficulties of this double highway tunnel. Ills. Serial. 1st part. 3000 w. Il Cemento—Jan. 13, 1912. No. 31414 D.

Waterproofing

Waterproofing Concrete Structures. Illustrates and describes methods adopted on the C., B. & Q. Ry. in Chicago. 800 w. Ry Gaz, Lond—March 8, 1912. No. 31252 A.

MATERIALS OF CONSTRUCTION

Cement

The Effect of High-Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete. Rudolph J. Wig. Reports investigations to determine what acceleration hardening could be obtained by using steam under pressure, with corresponding higher temperatures. Ills. 25 pages. Bureau of Stand, Tech. paper No. 5—Sept. 5, 1911. No. 31606 N.

The Hardening of Cement Mortar in Frost (Verharding van cement-mortels biz vorst). L. Bienfait and H. Baucke. Experiments with various substances to prevent freezing. 3000 w. De Ingenieur—Feb. 10, 1912. No. 31379 D.

See also Blast-Furnace Slag, under MINING AND METALLURGY, *Iron and Steel*; and Cement Mills, under MINING AND METALLURGY, *Minor Minerals*.

Cement Storage

The storage of Portland Cement. Suggestions for dealers, contractors and users. Ills. 1000 w. Cement—Feb., 1912. No. 31497 C.

Concrete

Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concretes, Together with Tests of Damp-proofing and Waterproofing Compounds and Materials. R. J. Wig and P. H. Bates. Report of tests. Ills. 127 pages. Bureau of Stand, Tech. paper No. 3—Aug. 22, 1911. No. 31607 N.

Specifications and Methods of Tests for Concrete Materials. Important sections from the committee report presented to the National Assn. of Cement Users. 2500 w. Eng Rec—March 30, 1912. No. 31658.

Steam Tests on Concrete and Mortar. Notes taken from a report of tests made at the St. Louis laboratories to determine what acceleration in hardening could be obtained by using steam under pressure with corresponding higher temperatures. 3000 w. Eng Rec—March 16, 1912. No. 31218.

Field Compression Tests of Concrete. G. H. Bayles. Report of tests and results in connection with the construction of buildings in Brooklyn, N. Y. 2000 w. Eng News—March 28, 1912. No. 31630.

New Concrete and Reinforced Concrete Testing Machines (Neue Beton- und Eisenbeton-Prüfmaschinen). J. Schmidt. Machines for determining the proper mixing of concrete and also for testing. Ills. Serial. 1st part. Elek Rundschau—Feb. 28, 1912. No. 31378 D.

See also Concrete, and Shops, under *Construction*.

Lime

Hydrated Lime, and Tests Showing the Comparative Strength of Different Kinds of Lime Mortars. W. B. Joseph. Explains the advantages of hydrated lime, the methods of manufacture in use in its preparation, tests and results. 2000 w. Cornell Civ Engr—March, 1912. No. 31592 C.

Protective Coatings

Protective Coatings. Walther Riddle. Brief discussion of materials used and their applications. 3500 w. Pro Engrs' Soc of W Penn—Feb., 1912. No. 31443 D.

Reinforced Concrete

See Reinforced Concrete, and Viaducts, under *Bridges*; Buildings, and Roofs, under *Construction*; Sewer Pipes, under *Municipal*; Docks, under *Waterways and Harbors*; and Ties, under RAILWAY ENGINEERING, *Permanent Way and Buildings*.

Reinforced Concrete Beams

Shearing Stresses in Concrete Steel Beams. Hector R. Burroughs. Investigates the actual practical utility of stirrups. 1000 w. Eng Rec—March 23, 1912. No. 31486.

Calculations on Compound Columns (Zur Berechnung der Verbundsäulen). O. Domke. Amendments suggested to the formulas worked out by Dr. von Emperger on beams. 1700 w. Beton u Eisen—Feb. 26, 1912. No. 31352 E.

Reinforced Concrete Slabs

Measurements of Stresses in Floor Systems of Reinforced Concrete Buildings. Extracts from a report presented by A. N. Talbot to the Nat. Assn. of Cement Users. Describes tests made in the Wexalden Building, Chicago. 2500 w. Eng Rec—March 23, 1912. No. 31482.

Tests of a Reinforced Concrete Flat Slab Building Floor to Determine Actual Stresses. From a paper by W. K. Hatt, before the Indiana Engng. Soc. A summary of recent tests. 2000 w. Engng & Con—March 13, 1912. No. 31180.

See also Floors, under *Construction*.

Steel

Notes on Structural Steel Designs. Albert Reichmann. Considers features that should be investigated in designing steel structures. General discussion follows. 10000 w. Jour W Soc of Engrs—Feb., 1912. No. 31196 D.

Timber

Timber Testing in the Forest Products Laboratory. Harold R. Winter. An account of research work as carried out by the Forest Service of the U. S. Department of Agriculture in co-operation with the University of Wisconsin. Ills. 3500 w. Jour Worcester Poly Inst—March, 1912. No. 31534 C.

Timber Expansion in Flumes; Causes and Remedies. Godfrey Sperling. From Trans. of Am. Met. Soc. Describes the longitudinal expansion of some flumes constructed in 1910 in Idaho. 1400 w. Min & Engng Wld—March 16, 1912. No. 31233.

\$30,000,000 in Wood Wastes. F. P. Veitch and M. G. Donk. From Bul. 144, Bureau of Chem., Dept. of Agri. (U. S.). On the utilizing of waste wood from the lumber industry of the South and the Northwest. 3500 w. Mfrs' Rec—March 21, 1912. No. 31448.

Wood Distillation: 1910. Information from the Federal annual report on the statistics of forest products. 900 w. Bureau of Census—Dec. 20, 1911. No. 31288 N.

Veneers: 1910. Information from the annual Federal report on the statistics of forest products. 1000 w. Bureau of Census—Dec. 20, 1911. No. 31287 N.

Pulp-wood Consumption: 1910. Information from the annual Federal report on the statistics of forest products. 2500 w. Bureau of Census—Dec. 20, 1911. No. 31286 N.

Tests on the Elasticity and Strength of Bamboo, Acacia, Ash and Hickory Timbers (Versuche über die Elastizität und Festigkeit von Bambus, Akazien, Eschen- und Hickoryholz). R. Baumann. Description of testing methods employed and results obtained. Ills. 3300 w. Zeitschr des Ver deutscher Ing—Feb. 10, 1912. No. 31359 D.

Timber Preservation

A Visual Method for Determining the Penetration of Inorganic Salts in Treated Wood. E. Baleman. Brief description. 600 w. Ry Age Gaz—March 15, 1912. No. 31216.

Wood Substitutes

Some Refractory Substitutes for Wood. Abstract of a paper by Charles L. Norton. Considers attempts to preserve wood

by chemical treatment and describes a material called asbestos wood. Discussion. Ills. 2200 w. Jour Am Soc of Mech Engrs—March, 1912. No. 31566 D.

MEASUREMENT

Arithmetical Mean

Application of the Arithmetical Mean. Julian C. Smallwood. Considers its application to engineering observations and some of the errors resulting from its indiscriminate use. 800 w. Power—March 12, 1912. No. 31122.

Slide-Rules

Slide-Rules for Stream and Canal Measurement (Rechenschieber für Fluss- und Kanalbau). Dr. Kaumann. A scale for the rapid calculation of velocities, cross-sections, etc., based on the several formulas for such determinations. Ills. 1800 w. Zeit f d Ges Turbinenwesen—Feb. 29, 1912. No. 31310 D.

Stream Gauging

Flow through Triangular Notches or Weirs. Ralph B. Daudt. Description and summary of tests conducted in the Hydraulic Laboratory at Cornell University. Ills. 2000 w. Cornell Civ Engr—March, 1912. No. 31590 C.

See also Slide-Rules, under *Measurement*.

MUNICIPAL

Drainage

Drainage Power Plant at New Orleans. Cecil P. Poole. Illustrated description of a power drainage system made necessary by the low level of the city. 2000 w. Power—March 26, 1912. No. 31513.

Drainage Methods in Santiago de Chile (Rioleringswerken van Santiago de Chile). G. H. van Mourik Broekman. Detailed description of the drainage and sewage system. Maps and Ills. 3800 w. De Ingenieur—Feb. 17, 1912. No. 31380 D.

See also same heading, under *Waterways and Harbors*.

Refuse Disposal

An Economic Study of the Four Alternate Methods Considered for the Disposal of the Garbage, Rubbish and Ashes of Toronto. Brief descriptions of the projects with estimates of cost. 3500 w. Engng & Con—March 27, 1912. No. 31620.

Methods of Garbage Collection in Milwaukee, Present and Proposed. The Estimated Saving in Cost Under New Method. Describes the present and proposed systems and states savings expected. 4000 w. Engng & Con—March 20, 1912. No. 31455.

Sanitation

The New Public Health. H. W. Hill. First of a series of articles stating the principles of modern official public health work. 1800 w. Eng News—Feb. 29, 1912. No. 30936.

Sewage Works and Street Gullies as Breeding Grounds of Mosquitoes. Dr.

Elwin H. T. Nash. Illustrated account of an effort in England to locate the breeding places of gnats and mosquitoes. 2500 w. Surveyor—March 15, 1912. No. 31054 A.

Sewage Disposal

The Chemical Principles Involved in Sewage Disposal. George G. Nasmith. Read before the Can. Pub. Health Assn. Considers methods, concluding that trickling filters are bound to displace all other forms. 2500 w. Can Engr—March 7, 1912. No. 31112.

Sewage Sludge and its Disposal. J. Grossmann. Read before the Manchester Sec. of the Soc. of Chem. Ind. Considers briefly ways of disposing and processes used, and refers to a new method of disposal by means of distillation with superheated steam. 4500 w. Surveyor—March 1, 1912. No. 31140 A.

Electrolytic Sewage Treatment. Howard V. Hinkley. Information concerning a plant in Oklahoma City, giving bacterial reports and operating costs. Also a review of the attempts to use electricity in the purification of water and sewage, and editorial. Ills. 9000 w. Eng News—March 21, 1912. No. 31468.

Sewage Purification at Atlanta. William A. Hansell, Jr. Illustrated description of one of the three plants to treat the sewage of the city, including the Imhoff tanks. 2500 w. Eng News—March 14, 1912. No. 31182.

Installing a Small Sewage Disposal Plant. Henry N. Ogden. Discusses sewage disposal for country houses, the essentials, septic tanks and their limitations, etc. Ills. 2500 w. Dom Engng—March 16, 1912. No. 31242.

Pittsburg Sewage Disposal Reports. Gives outline of reports protesting against a proposed heavy outlay, with explanation of conditions. Also editorial. 8500 w. Eng News—Feb. 29, 1912. No. 30940.

Sewage Pumps

See Pumps, under *MECHANICAL ENGINEERING, Hydraulic Machinery*.

Sewer Pipes

Reinforced Concrete Pipe Construction for Regina Sewer. W. R. Harris. Describes the construction of a modern sewerage system in this city of Saskatchewan, Canada. 3800 w. Cement & Eng News—March, 1912. No. 31274.

Sewers

Piney Branch Trunk Sewer Outlet, Rock Creek Park, Washington. Illustrates and describes the decorative treatment of an outfall in District of Columbia, where flow of sewage is regulated automatically. 2000 w. Eng Rec—March 23, 1912. No. 31479.

Cleveland Intercepting Sewer System. J. M. Estep. Outlines a project to divert the sewage from the rivers and lake front, describing the leading features of the work. Ills. 3000 w. Eng News—March 28, 1912. No. 31631.

Snow Removal

Coping with Snow in Boston. Edward Dana. Describes the snow-fighting methods used on the Boston Elevated Ry. and the surface lines. 1000 w. Elec Ry Jour—March 9, 1912. No. 31107.

ROADS AND PAVEMENTS**Auto Power**

Building Good Roads by Auto Power. Rex Beresford. Illustrated description of a cheap way of improving highways. 2200 w. Sci Am—March 16, 1912. No. 31166.

Utilization of Motor-Truck Trains in the Maintenance of Trunk Highways. Logan Waller Page. Read before the Am. Assn. for the Adv. of Sci. Suggestions for an automobile equipment for maintenance of road surface. Ills. 3000 w. Horseless Age—March 27, 1912. No. 31625.

Bitumens

Uses of Bitumens on Wisconsin Roads. H. J. Kuelling. Considers the material, best practice, methods, etc., in a general way. 3500 w. Wis Engr—March, 1912. No. 31575 C.

Concrete

Concrete Paving in Eight Cities. Reports by different writers from cities of the Middle West. Ills. 11000 w. Munic Jour of Engr—March 21, 1912. No. 31460.

Construction

Good Roads and How to Build Them. Logan Waller Page. Deals with building methods in the United States, the materials, maintenance, administration, etc. 2500 w. Sci Am—March 16, 1912. No. 31167.

The Road: Past, Present and Future. John H. A. Macdonald. Reviews road building methods and discusses future requirements. 9000 w. Surveyor—Feb. 23, 1912. No. 31024 A.

Permanent Structures. James S. Bell. Read before the Ontario Good Roads Assn. Considers materials, especially concrete, design, inspection, etc. 2500 w. Can Engr—Feb. 29, 1912. No. 30947.

County Road Construction in Ontario. W. A. McLean. Address before the Ontario Good Roads Assn. Discusses methods of construction now approved, and related subjects. 3500 w. Can Engr—Feb. 29, 1912. No. 30946.

See also Auto Power, under *Roads and Pavements*.

Cost Data

Cost Data on Hauling Stone with a 22-Horse-Power Traction Engine and Stone Spreading Cars, Gatchellville Road, York County, Pennsylvania. John F. Hammond. Ills. 1000 w. Engng & Con—March 27, 1912. No. 31617.

Delaware

The Coleman du Pont Highway Through the State of Delaware. Coleman du Pont. Illustrated account of this 110-mile road to be constructed and maintained. 2000 w. Sci Am—March 16, 1912. No. 31169.

Dust Prevention

Proposals for Dust Suppression and Road Improvement. Dr. Guglielminetti. Shows the problem to be more or less a question of money. 2500 w. Surveyor—Feb. 23, 1912. No. 31025 A.

Gravel

Methods and Costs of Constructing a Stone-Gravel Road on a Sand Sub-grade in Menominee County, Michigan. Illustrated description of methods used, with itemized costs. 2000 w. Engng & Con—March 13, 1912. No. 31178.

Highways

State Highway Construction in New York. Editorial review of the report of the State Highway Commission, and discussion of the increased cost of maintenance since the use of motor vehicles. 2000 w. Eng News—Feb. 29, 1912. No. 30941.

Legislation

The State Administration of Public Highways in the United States. An explanation of the aid given and the laws regulating the aid in different states. 2500 w. Eng News—March 28, 1912. No. 31633.

Location

Methods of Locating a New Highway Over Florida Mountain in the Hoosac Range in Western Massachusetts. Andrew M. Lovis. Explains the problem of improving this highway, describing the existing road and the surveys for this season. 2500 w. Map. Engng & Con—March 6, 1912. No. 31066.

Maintenance

See Auto Power, under *Roads and Pavements*.

Maintenance Costs

Some Erroneous Estimates of the Cost of Pavement Maintenance. Editorial criticism of the report of the Cambridge (Mass.) commission. 1800 w. Engng & Con—March 13, 1912. No. 31175.

Proper Methods of Recording, Interpreting and Estimating Road and Pavement Maintenance Costs. Aims to show correct methods. 2000 w. Engng & Con—March 20, 1912. No. 31453.

Material

Some Considerations on the Choice of a Pavement. Leonard S. Smith. Discusses the considerations affecting the choice, especially the construction, best suited to the service. Ills. 1800 w. Wis Engr—March, 1912. No. 31574 C.

Steam Rollers

Instructions to Operators of Steam Rollers. Gives the instructions issued by the Illinois State Highway Commission. 2500 w. Engng & Con—March 27, 1912. No. 31618.

Systems

Peel County Roads. C. R. Wheelock. Read before the Ontario Good Roads Assn. Describes the system adopted, said to be one of the best in the province. 1500 w. Can Engr—March 14, 1912. No. 31202.

WATER SUPPLY

Aqueducts

Preventing Leakage from the Washington Aqueduct at Cabin John Bridge. Describes lining the old brick conduit with cast-iron segments plastered with mortar on the inside and grouted from the outside. Ills. 2000 w. Eng Rec—March 9, 1912. No. 31091.

Conduits

Enclosing a Sewage-Laden Stream in a Triple-Barrel Concrete Conduit. Illustrates and describes the construction of the Jones' Falls conduits at Baltimore. 3000 w. Eng Rec—March 16, 1912. No. 31217.

Conservation

Mountain Drainage and Water Regulation (Le sistemazione montane ed il regime delle acque). Italo Maganzini and Carlo Valentini. A general treatise on the conservation of mountain run-off waters. 1500 w. Ann della Soc d Ing e d Arch Ital—Jan. 1, 1912. No. 31418 E.

Dam Failures

Failure of a Log and Earth Fill Dam at Union Bay, B. C. A. K. Mitchell. Illustrated account of a failure that occurred Feb. 10, 1912. 1500 w. Eng News—Feb. 29, 1912. No. 30942.

Dams

Masonry Dams. Edward Wegmann. Historical, theoretical, and practical review and discussion. Ills. 11500 w. Jour Am Soc of Engng Con—Jan., 1912. No. 31431 C.

Evaporation

California Evaporation Records. Edwin Duryea, Jr. Gives summaries of two series of records. 2500 w. Eng News—Feb. 29, 1912. No. 30937.

Filtration

The Condition of Old Mechanical Filters. Report upon the plant of Quincy, Ill., which has been in service 20 years. 2000 w. Eng Rec—March 30, 1912. No. 31660.

The Rapid Mechanical Filtration Plant of the Montreal Water & Power Company. Illustrated description of this new plant. The compressed air and water used for washing the filters will be stored in a telescopic tank similar to a gasholder. 2500 w. Eng Rec—March 9, 1912. No. 31085.

Headgates

New Roller Headgates at the McCall Ferry Plant. Illustrated description of the gates and the operating mechanism. 2000 w. Eng Rec—March 9, 1912. No. 31089.

Irrigation

Chart for Solution of Problems in Irrigating Waters. H. C. Ogden. Gives a chart for irrigation 0.2 feet in depth, explaining its use by examples. 1000 w. Eng Rec—March 9, 1912. No. 31090.

Electric Power for Irrigation in Colorado. W. H. Bullock. Considers applications of the commercial squirrel cage induction

motor either belted or direct-connected to a centrifugal pump. Ills. 2200 w. Elec Jour—March, 1912. No. 31600.

Description of the Prosser Division of the Sunnyside Unit, Yakima Project, United States Reclamation Service. E. A. Moritz. Deals with the construction of a portion of this unit consisting of about 2500 acres involving all kinds of irrigation construction. Ills. 7000 w. Eng News—March 28, 1912. No. 31627.

Six Million Dollars for Irrigation. Albert Phenix. Illustrated account of an interesting project in progress in the Medina River Valley in the vicinity of San Antonio, Texas. 3500 w. Mfrs' Rec—March 21, 1912. No. 31447.

The Canadian Pacific Railway Company's Irrigation Project in Alberta. Illustrates and describes a composite dam with earth body and concrete spillway which will divert water from the Bow River. 2500 w. Eng Rec—March 23, 1912. No. 31484.

Hydro-Electric Irrigation Project. H. B. McDermid. Illustrates and describes features of the Minidoka project, Idaho. 2000 w. Power—March 12, 1912. No. 31124.

Pipes

Pipe Questions at the International Hygiene Congress in Dresden, and Actual Conditions (Die Rohrfrage auf der Internationalen Hygieneausstellung in Dresden und in der Praxis). G. Blanchart. Discusses the views on corrosion placed before the congress, and illustrates actual conditions. Ills. 1800 w. Stahl u Eisen—Feb. 29, 1912. No. 31323 D.

Pipe Questions at the International Hygiene Congress in Dresden (Die Rohrfrage auf der Internationalen Hygieneausstellung in Dresden). O. Kröhnke. Replies to previous article by Herr Blanchart, and additional notes to article by the author at an earlier date. Ills. 1400 w. Stahl u Eisen—March 7, 1912. No. 31342 D.

Pipe Thawing

Thawing 6-in. Water Main Under East River, New York. Describes thawing by electricity the main from 140th street to North Brother Island. Ills. 1000 w. Elec Wld—March 23, 1912. No. 31508.

Pumps

See same heading, under MECHANICAL ENGINEERING, *Hydraulic Machinery*.

Purification

Water Purification. Four short papers by different authors, discussed together. 5500 w. Jour Cleveland Engng Soc—March, 1912. No. 31572 D.

Disinfecting Lake Water with Calcium Hypochlorite. From a paper by Dr. Arthur Lederer and Frank Bachmann, read before the Ill. Water Supply Assn. Reports results on the shores of the Great Lakes. 3000 w. Eng Rec—March 30, 1912. No. 31664.

Evanston's Experience with Hypochlorite of Lime and Typhoid Fever. W. Lee Lewis. Gives a summary of results of sterilizing Lake Michigan water. 2000 w. Eng Rec—March 16, 1912. No. 31220.

Reservoirs

An Equalizer Reservoir on a Gravity Flow Line. A 300,000 gal. reinforced-concrete reservoir, and 2½ miles of gravity pipe line recently completed at Austin, Minn., are illustrated and described. 1000 w. Eng Rec—March 30, 1912. No. 31662.

Settling Basins

New Settling Basin of the Water Works at Kansas City. Wynkoop Kiersted. Illustrated detailed description of this new basin and its operation. 4000 w. Eng News—Feb. 29, 1912. No. 30934.

Spillways

A Method of Computing the Size of Spillway for a Dam. H. K. Palmer. Develops a method. 1500 w. Eng News—March 21, 1912. No. 31466.

Stream Flow

See Slide-Rules, under *Measurement*.

Typhoid

Typhoid Outbreak, Cedar Falls, Iowa. A. L. Grover and R. B. Dole. An account of an outbreak due to contamination of the water supply. 1800 w. Eng News—March 21, 1912. No. 31467.

Waste

Water Measurement and Prevention of Water Waste in New York City. An official statement from Henry S. Thompson, Commissioner, New York City. Map and report of investigations and pitometer surveys in waterfront districts. 1500 w. Eng News—March 14, 1912. No. 31183.

Water Power

Power Development at Sandy Falls on the Mattagami River. Illustrated detailed description of a plant supplying power to the Porcupine gold fields. 1000 w. Eng Rec—March 30, 1912. No. 31656.

Water Regulation

Water Power Utilities and the New Water Legislation (Die Wasserkraftausnutzung und das neue Wasserrecht). Heinrich Schreiber. Discusses the effects of the proposed water regulation upon the development of power schemes. 6400 w. Elektrotechnik u Maschinenbau—March 3, 1912. No. 31375 D.

The Third Draft of Prussian Water and Mining Laws (Der dritte Entwurf eines preussischen Wassergesetzes und der Bergbau). G. Wulf. Especially concerning the use and regulation of water in connection with mining enterprises. Serial. 1st part. 4500 w. Glückauf—March 2, 1912. No. 31345 D.

Water Resources

The Water Resources of Minnesota; Storage Developments Planned and Under Way. George C. Ralph. Read before the Minn. Survs. & Engrs.' Soc. Describes work to prevent floods and conserve the

river waters. Ills. 1500 w. Engng & Con—March 13, 1912. No. 31179.

Water Service

Report of Committee on Water Service. Report (1) on design and relative economy of track pans; (2) plans and specifications for tank supports; (3) on the use of reinforced concrete for water tanks and supports. 9000 w. Bul Am Ry Engng Assn—Dec., 1911. No. 31284 N.

WATERWAYS AND HARBORS

Breakwaters

Breakwater at Svaneke, Island of Bornholm. Illustrated description of work undertaken to protect dangerous fishery harbors in the Baltic Sea. 1200 w. Engng—March 15, 1912. No. 31526 A.

Canals

See Slide-Rules, under *Measurement*.

Docks

A Concrete and Steel Ore Dock Having New Features in Its Design. W. E. King. Illustrates and describes details of the fireproof dock of the Great Northern Ry., at Allouez Bay. 2500 w. Eng Rec—March 9, 1912. No. 31084.

Reinforced Concrete in Ore Dock Construction. Illustrated detailed description of the construction of the concrete ore dock at Cleveland, O. 1200 w. Cement Age—March, 1912. No. 31458.

See also Floating Docks, under MARINE AND NAVAL ENGINEERING.

Drainage

Procedure Followed in Public Drainage Ditch Work in Southern Minnesota with General Costs of Ditch Work. Abstract of a paper by C. W. Gove, read before the Minn. Survs. & Engrs.' Soc. Describes a method of mapping, making profiles and recording surveys and estimates. 3000 w. Engng & Con—March 27, 1912. No. 31621.

Methods of Tile Draining Gumbo, Hardpan, and Seepy Land in Kansas—General Instructions and Costs. H. B. Walker. Abstract of paper before the Kansas Engng. Soc. Discusses methods and gives directions for mapping surveys and estimating costs. 2500 w. Engng & Con—March 27, 1912. No. 31622.

Dredging

Harbour Dredging. Brysson Cunningham. Illustrates and describes modern machinery for channel improvement. 3000 w. Cassier's Mag—March, 1912. No. 31188 B.

Dredges and Dredging in Mobile Harbor, Alabama; Records and Cost of Dredge Work. Condensed paper by J. M. Pratt, in *Prof. Mem.* A comparison of clam shell and pipe line dredge work as to output and cost. Gives records of work of a seagoing hopper dredge, and other information. 4500 w. Engng & Con—March 20, 1912. No. 31454.

Fender Chains

A New Fender Chain and Resistance Unit. Illustrated description of a me-

chanical device which when subjected to tension exceeding a defined amount extends and offers resistance to the extending force. 500 w. Engr, Lond—March 8, 1912. No. 31267 A.

Great Lakes

The Use of the Great Lakes. Robert R. McCormick. Discusses views in a paper by Gardner S. Williams, and the rights of the Great Lakes in water commerce, power, and sanitation. General discussion. 14500 w. Jour W Soc of Engrs—Feb., 1912. No. 31197 D.

Harbors

Improvement of Tacoma Harbor. Gives details of a plan to develop and control an important waterfront. 1800 w. Marine Rev—March, 1912. No. 31225 C.

Locks

See Panama Canal, under *Waterways and Harbors*.

Panama Canal

Fixing the Tolls on the Panama Canal. Editorial review of a study by Prof. Johnson, which gives much information of the considerations which should govern the fixing of tolls. 2800 w. Eng Rec—March 2, 1912. No. 30979.

The Character of the Reported Volcanic Heat in Cluebra Cut, Panama Canal. Information from the official report explaining the cause. 2000 w. Engng & Con—March 27, 1912. No. 31615.

The Operation of the Locks of the Panama Canal. Describes the method of control at the Gatun locks, as given in the *Canal Record*. 2500 w. Eng Rec—March 2, 1912. No. 30983.

Industrial Motor Applications on the Panama Canal. F. C. Hanker. Illustrates and describes work accomplished by electric power in constructing the canal. Map. 2000 w. Elec Jour—March, 1912. No. 31598.

River Regulation

A Project for the Regulation of the River "Dranse" by Means of Three Successive Chutes (Projet d'Aménagement de la Rivière la Dranse au Moyen de Trois Chutes Successives). E. Pacoret. Proposed plan for the regulation of this river in times of flood, in combination with a

water power plant. Plate. 6500 w. Technique Moderne—March 1, 1912. No. 31397 D.

Shore Protection

Revetment Construction for a Railroad Bridge on the Missouri River. A. A. Schenck. Illustrates and describes a method of placing a willow mat and account of its service against erosion. 2000 w. Eng Rec—March 2, 1912. No. 30980.

Wharves

Canadian Northern Pacific Railway Company's Wharf at Port Mann, B. C. W. G. Swan. Illustrated description of this wharf and features of its construction. 2200 w. Can Engr—March 14, 1912. No. 31201.

MISCELLANY

Africa

Engineering on the Gold Coast. W. H. Barker. Illustrates and describes harbor and transportation work on the west coast of Africa. 1200 w. Cassier's Mag—March, 1912. No. 31186 B.

China

China and Chinese Engineering. W. D. B. Dodson. An interesting review of past and present conditions and the help needed for future development. 5000 w. Jour Assn of Engng Socs—Feb., 1912. No. 31195 C.

Drawings

A New Process for Reproducing Drawings on Paper, Cloth, etc., Instantaneously (Nouveau Procédé pour la Reproduction Instantanée des Calques sur tous Papiers, Toiles, etc.). M. H. Claude. Description of the so-called "graphitic" process. 3000 w. Mem Soc Ing Civ de France—Dec., 1911. No. 31388 G.

Philippines

Philippine Public Works. Excerpts from the annual report of Charles B. Elliott. Gives an outline of results in the different divisions of the Bureau of Public Works. Ills. 2500 w. Far East Rev—Jan., 1912. No. 31010 N.

Photography

Engineering Photography. Lyman B. Jackes. Suggestions, and description of methods used in such work. 3500 w. Can Engr—March 7, 1912. No. 31111.

ELECTRICAL ENGINEERING

COMMUNICATION

Leakage

Distributed Leakage in Telephone and Telegraph Systems. Frank F. Fowle. A comparison of methods for measuring resistance of insulation between open wires. 2500 w. Elec Wld—March 9, 1912. No. 31117.

Radiotelegraphy

Recent Experiments on Directive Wireless Telegraphy with Earth Antennæ. F.

Kiebitz. Abbreviated translation from the German. Describes investigations with "earth antennæ," conductors supported horizontally just above the ground. 3500 w. Elect'n, Lond—March 8, 1912. No. 31247 A.

Printing Telegraphy. Illustrated description of a system devised by A. M. Howland for sending secret messages by wireless telegraphy. Ills. 700 w. Sci Am Sup—March 30, 1912. No. 31648.

Regulation of Radiotelegraphy. Robert A. Morton, Jr. Discusses the need of regulation, the bill now before the U. S. Senate, and the principal objections against it. 3500 w. *Sci Am Sup*—March 23, 1912. No. 31428.

The Work of the U. S. Naval Radio-Telegraphic Laboratory. L. W. Austin. Reviews the general nature of the work. 5000 w. *Jour Am Soc of Nav Engrs*—Feb., 1912. No. 31492 H.

Submarine Cables

The Theory of the Submarine Telegraph Cable. H. W. Malcolm. A study of possible improvements in submarine cables in working speed, developing a method for obtaining arrival and sending curves by simple calculation, for any form of apparatus. 2000 w. *Elect'n Lond*—March 8, 1912. Serial. 1st part. No. 31248 A.

Anglo-Belgian Submarine Telephone Cable with Pupin Loading Coils. Also editorial. Information concerning the cable between St. Margaret's, in England, and La Panne in Belgium, discussing the construction and limitations of such cables. 2200 w. *Elec Wld*—March 16, 1912. No. 31241.

Telegraphy

See Submarine Cables, under *Communication*.

Telephony

Pupin Lines (Sur les Lignes Pupini-sées). M. Cohen. A review of the theory of the Pupin system for long-distance telephony, and its utility for American purposes. Discussions on the Denver-New York system by M. M. Devaux-Charbonnel and H. Planchon. Ills. 20000 w. *Bull Soc Int d'Electriciens*—Feb., 1912. No. 31402 F.

Telephone Systems in Italy (Per la sistemazione del servizio telefonico in Italia). Review of the progress and present state in telephony. Serial. 1st part. 6600 w. *Monit Tecnico*—Feb., 20, 1912. No. 31421 D.

See also Submarine Cables, under *Communication*.

DISTRIBUTION

Circuit Breakers

Degradation of Accumulative Energy. A. G. Collis. Abstract of a paper read before the S. Wales Inst. of Engrs. Intended as a sequel to a former paper on "Breaking High and Low Potential Circuits." Gives further oscillograph records of the effects of opening and closing various circuits. Also discussion. 4500 w. *Elect'n Lond*—Feb. 23, 1912. No. 31019 A.

Circuit closing in Electric Lines (Der Einschaltvorgang bei elektrischen Leitungen). R. Rüdenberg. Mathematical discussion. Diagrams. 5200 w. *Elektrotechnik u Maschinenbau*—Feb. 25, 1912. No. 31373 D.

Current Rectifiers

See Locomotives, under STREET AND ELECTRIC RAILWAYS.

Relays

Characteristics of Protective Relays. E. M. Hewlett. Describes the general characteristics of protective relays necessary for the automatic and selective action of circuit breaking and switching devices connected to electrical distributing systems. 1800 w. *Pro Am Inst of Elec Engrs*—March, 1912. No. 31583 F.

Wiring

Some Interesting Details of the Electric Wiring in a Large Office Building. F. G. Waldenfels. Illustrates and describes details introduced in a 21-story Chicago building. 2500 w. *Elec Rev & W Elect'n*—March 23, 1912. No. 31500.

Wiring Prices

Standardized Interior Wiring Prices. H. L. Parker. Explains the Baltimore plan of computing house-wiring costs on a combined basis of number of outlets and number of lamps or sockets. 3000 w. *Elec Wld*—March 9, 1912. No. 31118.

DYNAMOS AND MOTORS

Brushes

Brushes. W. R. Whitney. Describes experiments made with the view of assisting the improvement in the qualities of motor and generator brushes, particularly of the carbon type. Ills. 3000 w. *Jour Fr Inst*—March, 1912. No. 31570 D.

Commutation

Commutation (Ueber Kommutierung). Dr. Niethammer. Discusses mathematically the E. M. F. in D. C. Motors with and without interpoles, and also the flash-over in D. C. motors. Diagrams. 6400 w. *Elektrotech u Maschinenbau*—Feb. 11, 1912. No. 31372 D.

Flux

Air Gap Flux Distribution in Direct-Current Machines. Charles R. Moore. Describes experiments and discusses method developed by means of which the full load flux distribution of a d. c. machine may be predetermined. Ills. 4000 w. *Pro Am Inst of Elec Engrs*—March, 1912. No. 31578 F.

Leakage

Experimental Determination of the Leakage Factors in Transformers and Three-Phase Induction Motors (Die experimentelle Bestimmung des Streufaktors von Transformatoren und Drehstrommotoren). Dr. G. Benischke. Presenting formulæ for these determinations. Diagrams. 1600 w. *Elek Kraft u Bahnen*—Feb. 14, 1912. No. 31367 D.

Motor Starters

Motor Starters for Mining Work. A. P. Drake. Part I. deals with continuous-current starters, and Part II. with alternating-current starters. Ills. 3500 w. *Ir & Coal Trds Rev*—Feb. 23, 1912. No. 31049 A.

Synchronous Motors

Three Phase Synchronous Motors without Direct Current Excitation (Drehfeld-Synchronmotoren ohne Gleichstromerreg-

ung). G. Benischke. Describes the operation of this type. 2200 w. *Elektrotechnik u Maschinenbau*—March 3, 1912. No. 31374 D.

ELECTRO-CHEMISTRY

Electric Furnaces

Experiments with a Girod Steel Furnace. Editorial review of an article in *Stahl und Eisen*, by Dr.-Ing. A. Müller, giving an account of the working of a 3-ton Girod furnace installed at Oberhausen. Ills. 2500 w. *Engng*—Feb. 23, 1912. No. 31034 A.

Hérault Electric Furnace at Brain-tree. Illustrates and describes a furnace of two tons' capacity, employed to make steel for castings. 600 w. *Ir & Coal Trds Rev*—March 8, 1912. No. 31270 A.

Electroplating

Purity as a Requisite in Silver Anodes. J. L. R. Brown. Address to the Nat. Electroplaters' Assn. Discusses bad results from the use of impure silver. 2000 w. *Brass Wld*—March, 1912. No. 31445.

Hot-Cyanide Copper Solution. Seymour W. Rowsbar. Information concerning solutions for copper plating. 2000 w. *Foundry*—March, 1912. No. 30954.

Nitric Acid

The Production of Nitric Acid from Atmospheric Nitrogen by Means of Coke Oven Gas. (Ausnutzung der Koksofen-gase zur Gewinnung von Salpetersäure aus dem Stickstoff der Luft.) Herr Doppelstein. Description of plant, apparatus and process, with details as to cost of operation. Ills. 6000 w. *Glückauf*—Feb. 24, 1912. No. 31335 D.

ELECTRO-PHYSICS

Alternating Currents

Alternating Current Engineering. William R. Bowker. Discussion of starting methods for A. C. motors, which do not involve an auto-transformer or resistance in rotor circuit. Diagrams. 1500 w. *So Elect'n*—March, 1912. No. 31098.

Dielectrics

On the Properties of Dielectrics in Alternating Fields. G. L. Addenbrooke. A brief sketch of results obtained in experimental research work. 1200 w. *Elect'n, Lond*—March 1, 1912. No. 31134 A.

Dielectrics Under Continuous and Alternating Currents (Essais des diélectriques sous des tensions continues et alternatives). F. Laporte and P. de la Gorge. Comparative experiments for determining the tendency toward rupture in cables under differences in potential. Diagrams. 7000 w. *Bul Soc Int d'Electriciens*—Jan., 1912. No. 31384 F.

The Influence of Frequency on Dielectric Rigidity (Influence de la Fréquence sur la Rigidité diélectrique). P. de la Gorge and P. Girault. Experiments on dielectric solids from increasing the current frequency. 1800 w. *Bul Soc Int d'Electriciens*—Jan., 1912. No. 31385 F.

Electrical Energy

Electrical Disturbances and the Nature of Electrical Energy. Charles P. Steinmetz. Reprint from *Gen. Elec. Rev.* Address before the Assn. of Edison Ill. Cos. 5000 w. *Sci Am Sup*—March 2, 1912. No. 30931.

Magnetism

The Magnetic Properties of Iron at Frequencies of 200,000 per Second. E. F. W. Alexanderson. Abstract of an article in *Elektrotech. Zeit.* Experimental investigations to determine iron losses and saturation limits in high-frequency machines. 1800 w. *Elect'n, Lond*—Feb. 23, 1912. No. 31020 A.

Comparative Studies on Magnetic Measurement (Recherches Relatives aux Mesures Magnétiques). R. Jouast. Comparisons on the results furnished by the Picou Permeameter and other methods. Tables and Diagrams. 10000 w. *Bul Soc Int d'Electriciens*—Feb., 1912. No. 31401 F.

Oscillations

A Summary of the Theory of the Production of Electric Oscillations. Aage S. M. Sörensen. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Abstract of the principles of arc and spark oscillators. 2000 w. *Elect'n, Lond*—Feb. 23, 1912. No. 31021 A.

Ozone

The Industrial Uses of Ozone. F. Mollwo Perkin. Information concerning ozone, its production and applications. Ills. 2800 w. *Nature*—Feb. 22, 1912. No. 31012 A.

Ultra-Violet Rays

Ultra-Violet Rays and their Practical Applications (Les Rayons Ultra-Violets et leurs Applications Pratiques). Daniel Berthelot. Discusses at length the characteristics of the rays and their uses in lighting, medicine and water purification. Ills. 37200 w. *Mem Soc Ing Cir de France*—Dec., 1911. No. 31389 G.

Vector Diagrams

A. C. Vector Diagrams. C. C. Hawkins. Shows there is a want of clearness in the minds of students as to the meaning of vector diagrams, according to whether the resultant is the diagonal of a parallelogram or the closing side of a triangle. 2000 w. *Elect'n, Lond*—March 15, 1912. No. 31521 A.

GENERATING STATIONS

Boosters

Reversible Boosters. C. Turnbull. Considers some of the problems and the beneficial use of batteries. 2000 w. *Elec Rev*—March 15, 1912. No. 31518 A.

Central Stations

Large Southern Central Stations. D. J. O'Brien. Illustrates and describes the combination steam-turbine and reciprocating-engine plant supplying light and power to Birmingham, Ala. 1500 w. *Power*—March 26, 1912. No. 31515.

Power System of the Pacific Mills. Abstract of a paper by Fred A. Wellen, describing the recently installed power system to supply electric current to the mills at Lawrence, Mass. 2000 w. Jour Am Soc of Mech Engrs—March, 1912. No. 31567 D.

Commercial Electrical Apparatus for 100,000-Volt Service. S. Q. Hayes. Abstract of paper read at the Turin Congress. Gives details of transformers, condenser type terminals, oil circuit-breakers and lightning arresters. 2500 w. Elect'n, Lond—March 15, 1912. No. 31520 A.

Combination Plant

A Combination Lighting, Heating and Ice Plant at Louisville, Ky. Illustrated description of modern practice in a 700 kw. station. 1800 w. Elec Wld—March 2, 1912. No. 30993.

Costs

Discussion on "Central Station Generation of Power at Mining Centers," Ft. Wayne, Ind., Feb. 2, 1912. Paper by J. V. Hunter is discussed. 2500 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31584 F.

England

Electrical Development in Stratford-on-Avon. Illustrated description of an interesting gas engine plant. 2000 w. Elec Rev, Lond—Feb. 23, 1912. No. 31013 A.

Germany

Modern German Electrical Plant. Prof. G. Klingenberg. Reprint from an article in *Zeit. des Ver. Deut. Ing.* Illustrated description of a 10,000-kw. plant on the Finow Canal, near Berlin. 1800 w. Power—March 5, 1912. No. 31000.

Hydro-Electric

A Municipal Hydroelectric Plant. Louis E. Ayres and Gardner S. Williams. Illustrated description of replacing steam by water power in the city of Sturgis, Mich. 2000 w. Eng Rec—March 2, 1912. No. 30981.

A New Hydroelectric Plant in Oregon. Extracts from a paper by Herman V. Schreiber, read before the Nat. Assn. of Cement Users. Describes a plant on the Clackamas River, 40 miles east of Portland, having a concrete dam and power house built on fissured volcanic rock foundations, made solid by grouting. Ills. 4500 w. Eng Rec—March 2, 1912. No. 31481.

Hydroelectric Station of the Cia Docas de Santos, Brazil. Illustrated description of a plant operating under a head of 2100 ft. The cemented flume was a task which covered more than seven years. 2500 w. Elec Wld—March 16, 1912. No. 31239.

The Hydro-Electric Power Scheme of the City of Winnipeg. Map and illustrated description of the scheme. 2500 w. Elect'n, Lond—March 1, 1912. Serial. 1st part. No. 31135 A.

See also Irrigation, under CIVIL ENGINEERING, *Water Supply*; and Oil-Burning Station, under *Generating Stations*.

Loads

Operation of Two Alternating Current Stations Through Parallel Circuits, and the Distribution of Load and Wattless Currents Between Them. J. W. Welsh. An explanation of the operation under various conditions. 3000 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31577 F.

Oil-Burning Station

Auxiliary Oil-Burning Station for Southern California District. Illustrated description of the Long Beach plant of the Edison Co. in operation as an auxiliary of the hydroelectric system now in operation. 3000 w. Elec Wld—March 9, 1912. No. 31116.

Power Plants

Economical Effect of Increasing Vacuum on Reciprocating Engine Plant. C. C. Hoke. Presents a "gross economy" formula for making comparative calculations. Also a method of arriving at the net economy. 2200 w. So Elect'n—March, 1912. No. 31097.

Hazard Mfg. Co.'s New Power Plant. Warren O. Rogers. Illustrated description of individual motor drive used on wire-rope making machinery. 1500 w. Power—March 12, 1912. No. 31119.

New Indianapolis Power Station. Illustrated detailed description of a new plant having an ultimate capacity of 48,000 kw. 3500 w. Elec Ry Jour—March 9, 1912. No. 31106.

Buenos Ayres and Pacific Railway Company's Power and Traction Installation at Bahia Blanca. Illustrated detailed description of a recently completed plant in Argentine Republic for the supply of light and power. 2500 w. Tram & Ry Wld—March 7, 1912. No. 31524 B.

Power Stations

Stuart Street Power Station, Manchester, Eng. Plan and brief description of this electric station. 1200 w. Engr, Lond—March 8, 1912. No. 31266 A.

New Power Station of Boston Elevated Railway Company. Illustrated description of an important a. c. generating station, with ultimate capacity of 125,000 kw. 2000 w. Elec Wld—March 23, 1912. No. 31506.

South Boston Power Station of Boston Elevated Railway. Illustrates and describes a recently completed station. There are two turbines of 15,000 kw. each and the ultimate capacity is 125,000 kw. 4000 w. Elec Ry Jour—March 2, 1912. No. 31003.

Rates

Graphical Analysis of the St. Louis Residence Rates. Hugo E. Eisenmenger. Gives a graphic representation of three-change rates. 700 w. Elec Wld—March 23, 1912. No. 31509.

Tariff for Electrical Energy, with Particular Reference to Domestic Tariffs. W. W. Lackie. Explains a system of charging in Great Britain. 4400 w. *Inst of Elec Engrs*—March 7, 1912. No. 31246 N.

Switchboards

Method of Manufacture of Marble Panels for Switchboards. H. C. Pratt. Describes the important work of electric power in quarrying and in the manufactures. Ills. 1000 w. *Elec Jour*—March, 1912. No. 31602.

LIGHTING

Condensers

The Use of Condensers on Alternating-Current Lighting Circuits. A. W. Ashton. Explains the application of condensers to lighting circuits. 1800 w. *Elec Rev, Lond*—March 1, 1912. No. 31132 A.

Illumination

The Principles of Industrial Lighting. Frank B. Rae, Jr. The present article discusses the general principles and benefits of good lighting. 3000 w. *Ind Engng*—March, 1912. Serial. 1st part. No. 31564 C.

Some Modern Problems of Illumination. T. Thorne Baker. Discusses ways and means of producing an illumination as nearly resembling daylight as possible. Ills. General discussion. 8500 w. *Jour Soc of Arts*—March 8, 1912. No. 31279 A.

The Influence of Illumination Conditions Upon Eye-Strain. Arthur J. Sweet. A study of the influence of illumination and the conditions producing eye-strain. Ills. 6500 w. *Elec Rev & W Elect'n*—March 16, 1912. No. 31227.

The Effect of Height of Suspension of Lamps Upon the Intensity of Illumination. W. E. Barrows, Jr. Shows that the "inverse-square law" must be used with caution under certain conditions. 800 w. *Elec Wld*—March 23, 1912. No. 31510.

Shop Lighting

Upkeep of Shop Lighting Systems. C. E. Clewell. The seventh of a series of articles on shop lighting. The present article deals with electrical circuits, use of carbons for arc lamps, inspection, etc. 2000 w. *Am Mach*—March 28, 1912. No. 31541.

Selecting the Light for the Foundry. B. G. Worth. From an address before the Newark (N. J.) Found. Assn. Considers the problem of lighting for molding, the choice of type of lamp and amount and distribution of illumination. 3000 w. *Ir Age*—March 14, 1912. No. 31162 C.

Train Lighting

See same heading, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

MEASUREMENT

Capacity

Relation of Flywheel and Motor Capacity for Industrial Loads. S. A. Fletcher and Charles R. Riker. Considers the interaction between flywheel and motor and

a graphical method of determining the relation. 2500 w. *Elec Jour*—March, 1912. No. 31605.

Inductance

Inductance of Coils. Morgan Brooks and H. M. Turner. Deals with the self-inductance of closely-wound cylindrical coils of wire without iron cores, giving tables and charts for obtaining the approximate inductance or reactance of coils of all dimensions. 72 pages. Univ of Illinois, Bul 53—Jan. 8, 1912. No. 31298 N.

Formulas and Tables for the Calculation of Mutual and Self-Inductance. Edward B. Rosa and Frederick W. Grover. A collection of all formulas which the writers have found of value in the calculation of mutual and self-inductance, particularly in non-magnetic circuits of low enough frequency to insure uniform distribution of current. 230 pages. Bul Bureau of Stand—Jan. 1, 1912. No. 31432 N.

Laboratories

The Gif Laboratory for Experimentation in Radioactive Substances (Le Laboratoire d'Essais des Substances Radioactives, à Gif). Jacques Danne. Description of laboratory, its location and equipment, and some determinations made there. Ills. 7500 w. *Genie Civil*—Feb. 24, 1912. No. 31408 D.

Photometry

A Photometric Investigation of Mercury-Vapor Lamps. Dr. J. Pole. Abstract of an article in *E. T. Z.* A report of photometric measurements. 1000 w. *Elec Rev, Lond*—March 15, 1912. No. 31519 A.

Pyrometry

Electric Heat Measurement and Remote Indicators with Especial Regard to Thermo-electric Methods (Elektrische Temperaturmessung und Fernablesung unter besonderer Berücksichtigung des thermoelektrischen Verfahrens). A. Schwartz. A technical discussion of the operation of electric pyrometers. Ills. Serial. 1st part. 5500 w. *Zeit des Ver deutscher Ing*—Feb. 10, 1912. No. 31358 D.

Rheostats

Notes on Rheostats. Considers rating, and on faults and troubles common to most rheostats. 2500 w. *Elec Rev, Lond*—Feb. 23, 1912. No. 31015 A.

Voltage

Determining Voltage at Distribution Center of Central Station System. Victor C. Vance. Diagrams and description of a compensating volt-meter, explaining its work. 1500 w. *So Elect'n*—March, 1912. No. 31099.

POWER APPLICATIONS

Agriculture

Electricity in Agriculture. Frank Koester. Discusses its use in the transportation of farm products, in irrigation, and the electric forcing of vege-

tation. Ills. 4000 w. Elec Rev & W Elect'n—March 23, 1912. No. 31499.

Astronomical Equipment

Electrical Installation of Mount Wilson Solar Observatory. Howard S. Knowlton. Illustrates and describes the equipment for operating the large telescope, and the various auxiliary apparatus. 3500 w. Elec Wld—March 23, 1912. No. 31505.

Bakeries

Electricity in Bakeries. Illustrates and describes interesting installations. 3500 w. Elec Rev & W Elect'n—March 16, 1912. No. 31226.

Electrical Machinery

Heating Effects in Electrical Machinery (Erwärmung elektrischer Maschinen). F. Niethammer. Calculations based on the investigations by H. D. Symons and Miles Walker in regard to methods of insulation to counteract the heat paths. 3000 w. Elek Kraft u Bahnen—March 4, 1912. No. 31370 D.

Industrial

Industrial Electric Service in the Southern States. A. D. Quackenbush. Illustrates and describes the 11000-volt lines, and the motor equipment of two large concerns near Mobile, Ala. 2500 w. Elec Wld—March 2, 1912. No. 30994.

Welding

See same heading under MECHANICAL ENGINEERING, *Machine Works and Foundries*.

TRANSMISSION

Alternating Current

Alternating Current on Shipboard. A. Norris. Detailed discussion of its adaptability to the requirements, and a statement of its advantages. 10800 w. Jour Am Soc of Nav Engrs—Feb, 1912. No. 31491 H.

Cables

The Manufacture of Telephone Cables at the Woolwich Works of Messrs. Siemens Brothers & Co., Ltd. Illustrated description of the manufacturing processes of dry-core air-space and telephone cables. 2500 w. Elect'n, Lond—Feb. 23, 1912. No. 31017 A.

High Voltage

Some Problems of High Voltage Transmissions. Charles P. Steinmetz. Considers line insulation, voltage regulation, control of branch circuits, etc. 3000 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31582 F.

The Southern Power Company's Transmission System. J. W. Fraser. Illustrated description of features of interest in the largest electrical generating and distributing system in the South. 7000 w. So Elect'n—March, 1912. No. 31096.

Insulation

The Thickness of Insulation on Wires and Cables. J. H. Lendi. Considers the

determination of the relations between diameter of wire and thickness of insulation for constant resistance and breakdown strength. 2000 w. Elec Wld—March 16, 1912. No. 31240.

Lines

The Southern Power Company's Transmission Lines. J. W. Fraser. Briefly reviews the history of transmission in America, and gives an illustrated detailed description of the 100,000 volt lines of this company. 5000 w. Can Soc of Civ Engrs—Nov. 23, 1911. No. 31295 N.

Line Stresses

Mechanical Stresses in Transmission Lines. A. Guell. Discusses stresses due to dead weight, wind pressure, and changes of temperature. 31 pages. Univ of Illinois, Bul 54—Jan. 22, 1912. No. 31299 N.

Poles

Design and Construction of a Reinforced Concrete Telegraph Pole Line Across the Hackensack Meadows, New Jersey. A paper by George Gibbs, read before the Nat. Assn. of Cement Users. Illustrated description of a pole line for the Pennsylvania R. R., the poles to be of reinforced concrete to avoid rapid deterioration. 1500 w. Engng & Con—March 27, 1912. No. 31623.

Three Phase

Inductive Reactance of Three-Phase Aerial Circuits. R. S. Brown. Gives a graphical representation of the reactance for unsymmetrically arranged conductors. 500 w. Elec Wld—March 23, 1912. No. 31507.

Notes on Three-Phase Power Measurement (Note sur les Mesures de Puissance en triphasé). Camille Legrand. Mathematical determinations. Diagrams. 1800 w. Soc Belge des Elec—January, 1912. No. 31390 E.

Voltage Regulation

The Voltage Regulation of Rotary Converters. Brief consideration of methods of regulating rotary converters. 1400 w. Engr, Lond—March 8, 1912. No. 31262 A.

MISCELLANY

Industry

The Power Phase of Industrial Engineering. A. F. Strouse. Deals with power in reference to utilization in manufacturing and in connection with new developments. 3000 w. Elec Jour—March, 1912. No. 31599.

Legislation

Electrical Law in the British Dominion. A summary of the law relating to electric light and power in the more important British colonies. 800 w. Elec Rev, Lond—Feb. 16, 1912. Serial. 1st part. No. 31014 A.

The Legal Regulation of the Production and Distribution of Electric Power

in Austria (Die Gesetzlichen Bestimmungen für die Erzeugung und Verteilung von Elektrischer Energie in Oesterreich). Heinrich Schreiber. Views upon the rights of the government to enforce such regulation. Serial. 1st Part. 1800 w. Elektrotechniker—Feb. 10, 1912. No. 31376 D.

Specifications

Specifications. F. S. Sells. Abstract of paper before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses what the author considers are undesirable features of the usual specification. 3500 w. Elect'n, Lond—Feb. 23, 1912. No. 31018 A.

INDUSTRIAL ECONOMY

Cost Methods

Cost Methods That Give the Executive Control of His Business. Benjamin A. Franklin. This fourth article of a series discusses the economical consideration of material by costs. 3500 w. Engineering Magazine—April, 1912. No. 31551 B.

Common Sense Cost-Keeping for Engineers. Severin Nelson. A discussion of the value of such systems, the objects, general principles, etc. 2,000 w. Mech Wld—Feb. 23, 1912. Serial. 1st part. No. 31029 A.

Education

Education in Science as a Preparation for Industrial Work. H. A. Roberts. Discusses matters of importance to educational experts. General discussion follows. 13500 w. Jour Soc of Arts—March 1, 1912. No. 31160 A.

A New Departure in Mining Education. H. G. Carmichael. An account of the mining department in connection with the new high school in Sudbury, and the work. 1000 w. Qr Bul Can Min Inst, No. 18—February, 1912. No. 31438 N.

The Berlin Technical High School at Charlottenburg. H. S. Rowell. An illustrated description of the buildings and the work. 3500 w. Engng—March 8, 1912. Serial. 1st part. No. 31258 A.

The Growth of Technical Public Instruction in Germany (Die Entwicklung des technischen Unterrichtswesens in Deutschland). Conrad Matschoss. History of such growth since its inception in Freiberg in 1765. 4900 w. Stahl u Eisen—Feb. 8, 1912. No. 31317 D.

Remarks on the Proper Training of the Engineer, and on the Question of Further Extension in Technical High Schools (Bemerkungen zur wissenschaftlichen Ausbildung der Ingenieure und zur Frage des weiteren Ausbaues der Technischen Hochschulen). C. Bach. Recommendations for further improvements. 7000 w. Zeitschr des Ver Deutscher Ing—Feb. 24, 1912. No. 31362 D.

Express Companies

Statistics of Express Companies. Abstract of the Interstate Commerce Commission's report for the year ending June 30, 1910, Covering 13 companies. 2500

w. Ry Age Gaz—March 13, 1912. No. 31209.

Indexing

Library Science as an Adjunct to Engineering. Louise B. Krause. An outline of the work of a professional librarian in a large engineering firm. 3000 w. Eng Rec—March 2, 1912. No. 30982.

Industrial Betterment

The Commonwealth Steel Co.'s Improvements. Illustrated description of the machine shop, store room, and club house at Granite City, Ill. 2500 w. Ir Trd Rev—March 21, 1912. No. 31451.

Labor

Labour Unrest in the United Kingdom. John B. C. Kershaw. An examination of British industrial conditions, discussing causes of international importance. 4500 w. Engineering Magazine—April, 1912. No. 31546 B.

The Proposed National Eight-Hour Law. Protests against the bill to limit the labor of mechanics and others employed on government work to eight hours a day. 2500 w. Ir Age—March 21, 1912. No. 31426 C.

The Coal Strike. Detailed Account of the past week's proceedings in England in connection with the coal strike. 5500 w. Col Guard—March 8, 1912. No. 31257 A.

Strike and Lock-Out Legislation. Editorial review of recent legislation, connected with lock-outs and strikes, in the British dominions and European countries. 2000 w. Engng—March 8, 1912. No. 31260 A.

Workings of the Erdman Act. Charles P. Neill. Abstract of part of Bul. 98 of the Bureau of Labor. An act which provides for the mediation and arbitration of controversies. 3500 w. Ry Age Gaz—March 29, 1912. No. 31638.

Labor Conditions on the Lower Amur. D'Arcy Weatherbe. Discusses the expulsion of Chinese from Russian mines north and east of the Amur. Ills. 1800 w. Min Mag—March, 1912. No. 31642 B.

Legislation on Night Work by Men, Women and Children Employed in French Industries (L'Etat Actuel de la Législation sur le Travail de Nuit des Hommes, Femmes et Enfants Employés dans l'In-

dustrie Francaise). A. Bean. Regulation on the hours of night labor by women and girls, and boys under 18 years. 2600 w. Genie Civil—Feb. 10, 1912. No. 31405 D.

Labor Conditions of Railway Employees in Prussia (Die Arbeitsverhältnisse der eisenbahnarbeiter in Preussen). Statistics on the labor situation, presenting tables giving age, percentage, hours of labor, invalid and pension service, wage scales, etc. 4200 w. Glückauf—Feb. 3, 1912. No. 31331 D.

Management

Scientific Management. Editorial discussion of the tendency toward specialization in manufacturing methods, stating the main features and advising moderation in the application of the methods. 3500 w. Engng—March 1, 1912. No. 31147 A.

The Successful Operation of a System of Scientific Management. Frank W. Sterling. Describes the practical working of a system of modern management as applied to a plant. Ills. 11500 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31495 H.

The Taylor System in Government Shops. The report of the House Committee to investigate various systems of shop management is in general adverse. 3500 w. Ir Age—March 21, 1912. No. 31427 C.

Scientific Management—A Suggestion. George F. Card. Considers a system to secure greater segregation and close record of machine performance. 1500 w. Am Mach—March 28, 1912. No. 31542.

Organization

Modern Organization. Charles De Lano Hine. Fourth article of a series. Discusses fallacies of accounting. 2500 w. Engineering Magazine—April, 1912. No. 31550 B.

Practical Efficiency Engineering. A study of the record in improved mechanical department efficiency on the Illinois Central within the past year and a half. Map. 3500 w. Ry Age Gaz—March 8, 1912. No. 31100.

Mechanical Department Organization. Reports more effective service in the improvement in efficiency in the department of the Illinois Central, as a result of increased supervision. 2000 w. Am Engr—March, 1912. No. 31058 C.

Recent Developments in the Unit System of Organization. Extracts from the discussion following the address by Chas. DeLano Hine on the adoption of this system on the Harriman Lines. 2000 w. Ry Age Gaz—March 15, 1912. No. 31210.

Some of the Elements of Factory Organization and Operation. C. B. Auel. Outlines methods of obtaining costs, and discusses their value. 4000 w. Sib Jour of Engng—Feb., 1912. No. 31441 C.

Plan of Organization for a Railway Track Labor Department. William S. Wollner. Rewritten from a report made for the officials of a western railway system. Gives a proposed plan. 2000 w. Ry Age Gaz—March 15, 1912. No. 31213.

Organization for the Season's Maintenance Work. Suggestions for economical and efficient work. 1800 w. Ry Age Gaz—March 15, 1912. No. 31212.

Evolution in Track and Signal Maintenance on the Union Pacific. A. M. Foote. Outline of an organization in force during the past two years on a portion of the Union Pacific. 2500 w. Ry Age Gaz—March 15, 1912. No. 31211.

Public Utilities

Going Value. Frank F. Fowle. A review and discussion of the more prominent methods of determining going value, with particular reference to public utilities. General discussion. 19500 w. Jour W Soc of Engrs—Feb., 1912. No. 31198 D.

Wage Systems

A Sliding Scale Premium System. John Nelson. Explains the Whitcomb-Blaisdell Machine Tool Co.'s method of equalizing production cost. 2000 w. Ir Age—March 14, 1912. No. 31161 C.

Piece-Work and Premium Systems. Frank Richards. Gives the writer's estimate of the premium system. 1800 w. Ir Age—March 14, 1912. No. 31163 C.

MARINE AND NAVAL ENGINEERING

Barges

The First American Built Diesel-Engined Oil Barge. Illustrated description of the 300-h. p. Diesel engine of the 200-ft. steel motor barge for the Standard Oil Co., N. Y. 2000 w. Int Marine Engng—March, 1912. No. 30996 C.

Compasses

The Gyrostatic Compass. Abstract of

a discourse by George K. B. Elphinstone, on "The Gyrostatic Compass and Practical Applications of Gyrostats." 2000 w. Engr, Lond—March 1, 1912. No. 31156 A.

Diesel Engines

See Barges and Oil Engines under MARINE AND NAVAL ENGINEERING, and Oil Engines under MECHANICAL ENGINEERING, *Combustion Motors*.

Dreadnoughts

A Comparison of the Cost of Dreadnoughts in England, Germany, France, Austria, and the United States. Translated from an article by Louis Barberis, in *Revista Marittima*. 3000 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31496 H.

Dry-Docks

The Dry-Dock at Ashtabula, Ohio. E. C. Bowen, Jr. Illustrated description of a dry-dock of mass concrete construction, built during the seasons of 1910-1911. 2200 w. Eng News—March 14, 1912. No. 31181.

Ferry Steamer

A Large Railway Ferry Steamer for the Volga. F. C. Coleman. Illustrated description of a boat designed for service under peculiarly difficult conditions. 1000 w. Sci Am Sup—March 9, 1912. No. 31075.

Fishing Boats

See Internal-Combustion Engines under MARINE AND NAVAL ENGINEERING.

Floating Derricks

See Derricks under MECHANICAL ENGINEERING, *Transporting and Conveying*.

Floating Docks

Floating Dock for Testing Submarine Boats. Illustrated description of a novel construction to enable external-pressure tests to be applied to the hulls of submarine-boats without having recourse to deep-sea hydrostatic diving tests. 500 w. Engng—Feb. 23, 1912. No. 31041 A.

Lifeboats

Motors for Lifeboats. Gives particulars of motor-driven lifeboats now in service, outlining the general conditions required in the construction of the motor and its accessories, and discussing critically a number of types. Ills. 3500 w. Engr, Lond—March 1, 1912. No. 31152 A.

"Maine"

The Raising of the Wreck of the U. S. Battleship "Maine." Official record of the preliminary operations up to June 30, 1911. 5000 w. Engng—March 15, 1912. No. 31530 A.

Marine Staging

The Piercy Travelling Stage for Maritime Work (Échafaudage mobile, système Piercy, pour travaux maritimes). Ch. Dantin. Description of this self-propelling staging, and some works where it has been successfully employed. Ills. and Plate. 3500 w. Genie Civil—March 2, 1912. No. 31410 D.

Motor Ships

The Twin Screw Motor Ship Selandia. A description of the ship and details of the engines and their work. Ills. 3500 w. Engr, Lond—March 8, 1912. Serial. 1st part. No. 31265 A.

Oil Engines

An Analysis of the Claims of the Marine Internal Combustion Engine. Aims

to give facts that will present an unprejudiced statement of the case of oil or steam for marine propulsion. Ills. Also editorial. 4500 w. Engr, Lond—March 15, 1912. No. 31532 A.

Internal-Combustion Engines for German Fishing-Boats. F. Romberg. Abbreviated translation of paper read before the Schiffbautechnische Gesellschaft. Illustrates and describes the Brons engine, as fulfilling the required conditions, and refers to other types. 2500 w. Engng—March 1, 1912. No. 31150 A.

The Ocean-Going Oil-Engined Ship "Sembilan." Drawings and description of the vessel and the engines. 1200 w. Engng—March 15, 1912. No. 31527 A.

Semi-Diesel Engine on the Yacht "Mairi." Illustrated description of this yacht, and its engines, fitted with a view to carrying out extensive experiments at sea as to the working of the semi-Diesel type. 2500 w. Engng—Feb. 23, 1912. No. 31036 A.

Propellers

Screw Propeller Design. C. W. Dyson. Considers the influence of the ratio between greatest immersed beam and length on load water line on block coefficient and on the choice of ship chart to use of any vessel. 1000 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31489 H.

Designing and Drawing a Screw Propeller. George Jepson. From *Elect'n and Mech*. Considers the drawing from the descriptive method in the present article. Ills. 1400 w. Mech Wld—March 8, 1912. Serial. 1st part. No. 31256 A.

A Defense from the Attacks of Kempf and Others Regarding Their Propeller Tests and Mine (Abwehr der Kempfschen Angriffe und einiges mehr über seine und meine Propellerversuche). Fr. Gehers. A refutation of some of the statements made by Kempf and a statement of experiments made. Ills. 5600 w. Schiffbau—Feb. 28, 1912. No. 31313 D.

Propulsion

Report of Shop Tests of the Starboard Propelling Unit of the U. S. S. "Henley." Reports tests made of a combination of reciprocating engine and turbine designed for maximum economy at cruising speed. Ills. 2200 w. Jour Am Soc of Nav Engr—Feb., 1912. No. 31487 H.

Electric Propulsion of Ships. Abstract of a talk by W. L. R. Emmet. 1800 w. Jour Am Soc of Mech Engrs—March, 1912. No. 31568 D.

Ship Resistance

Certain Aspects of Ship Resistance as Disclosed by the Performance of the Corrugated Sided Vessel "Monitoria." Arthur H. Haver. Considers results obtained from this vessel. Discussion. Plates. 14000 w. Trans N E Coast Inst of Engrs and Shipbldr—Jan., 1912. No. 31640 N.

Ship's Speed

Speed Moments (Fahrtmomente). Herr Rothe. Mathematical considerations on the resistance due to friction, etc., in the navigation of steamships. Diagrams. 3500 w. Schiffbau—Feb. 28, 1912. No. 31312 D.

Steam Engines

The Naval Reciprocating Steam Engine, Its Characteristics, Dimensions, and Economics. Ernest N. Janson. A review of the present state of development. 8500 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31488 H.

Steamships

The Twin Screw Steamship, "Princess Alice," for the British Columbia Coastal

Service of the Canadian Pacific Railway Co. Illustrations with brief description. 1200 w. Can Engr—March 7, 1912. No. 31110.

Turbine Operation

Turbine Stopping and Reversing (Stoppwag, Stoppzeit und Rückwärts-turbine). Herr Weitbrecht. Calculations on the strain in marine turbines, in stopping due to the resistance of the ship and propellers. Diagrams. 2000 w. Schiffbau—Feb. 14, 1912. No. 31311 D.

Turbines

Note on the Performance of Marine Turbines at Reduced Speed. E. Buckingham. 4500 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31493 H.

MECHANICAL ENGINEERING

AERONAUTICS

Aeroplanes

Soaring Flight. R. G. Ecob. A study of bird flight in its relation to the aeroplane. 1400 w. Sci Am Sup—March 30, 1912. No. 31651.

Air Resistance

The Resistance of the Air and Aviation. Dr. A. F. Zahm. An account of experiments made by the builder of the Eiffel tower in which special models were exposed to an artificial wind generated in a laboratory. Ills. 1500 w. Sci Am Sup—March, 1912. No. 31077.

Airships

Brucker's Trans-Atlantic Airship Expedition Getting Ready. Illustrated detailed description of this airship being built for the attempt to cross from Cape Verde Islands to Barbados with the trade winds. 1500 w. Sci Am—March 16, 1912. No. 31168.

Tendencies in the Development of Motor Air Ships (Entwicklungstendenzen des Motorluftschiffes). Conrad Mueller. Brief review of various aerial types, including the Zeppelin gas craft, the Wright glider, etc. 2000 w. Motorwagen—Feb. 10, 1912. No. 31316 D.

Biplanes

The Boland Tail-less Biplane. Illustrated description of an original American aeroplane. 1200 w. March 23, 1912. No. 31430.

The Albatross Biplane, Military Type 1912 (Der Albatros-Doppeldecker, Militärtyp, 1912). Franz Klee. Details of construction of this machine. Ills. and Plates. 1200 w. Motorwagen—Feb. 10, 1912. No. 31315 D.

Bracing

The Tension-Meter (Le Tension-Mètre). Captain Largier. A device for use especially in aeroplane construction for determining the tension in the wire bracing.

ing. Ills. 5600 w. Mem Soc Ing Civ de France—Dec., 1911. No. 31387 G.

Framework

Aeroplane Under-Carriages. From a paper by G. de Haviland, at the Inst. of Auto. Engrs. Shows the need of improvements, states the requirements, and discusses features. 1500 w. Engng—March 15, 1912. No. 31529 A.

Hydrogen

The Preparation of Hydrogen for the Use of Military Aeronautics (La Préparation de l'Hydrogène pour les Besoins de l'Aéronautique Militaire). C. Matignon. A presentation of the various methods of preparation for the use of dirigibles, etc. Ills. 6000 w. Technique Moderne (Supplément)—Feb. 15, 1912. No. 31396 D.

Military

Military Aeronautics in France. B. H. Barrington-Kennett. Information concerning the organization of the aeronautical service, types of aircraft, conditions, trials, etc. 3500 w. Jour Roy U Serv Inst—Feb., 1912. No. 31199 D.

Motor Design

The Engineer's Responsibility for the Air Craft of the Future. Horace B. Wild. A critical study of the mechanical and structural details of the latest aeroplane motors. Ills. Serial. Part 1. 5500 w. Engineering Magazine—April, 1912. No. 31552 B.

Singular Aviation Motors (Les Moteurs d'Aviation Singuliers). Henri Petit. Illustrating some of the peculiar features of modern motor designs. Ills. Serial. 1st part. 1800 w. La Nature—Feb. 10, 1912. No. 31386 D.

Propellers

Torque in Aeroplane Propellers. Dr. A. F. Zahm. Explains the theory and discusses practice. 2000 w. Sci Am Sup—March 2, 1912. No. 30928.

The Design of Model Propellers and Elastic Motors. E. A. Vessey. Describes experiments made with a view to finding the laws governing the twisting and untwisting of elastic skeins, in connection with propeller design. 5000 w. *Sci Am Sup*—March 30, 1912. No. 31650.

AUTOMOBILES

Battery Charging

Efficient Charging of Electric Automobile Batteries. J. F. Lincoln. Read before the Elec. Veh. Assn. Discusses charging batteries in series, and outlines an ideal system, in the present article. Ills. 1500 w. *Horseless Age*—March 27, 1912. Serial. 1st part. No. 31626.

Carbureters

Some Tests on Carbureters. George W. Munro. Outlines the problem of carburation for motor vehicle engines and points out the difficulties met in determining the performance of a carburetor as distinct from the performance of the engine. 2500 w. *Jour Am Soc of Mech Engrs*—March, 1912. No. 31565 D.

Car Overhauling

How to Place Your Car in Commission. Illustrated detailed directions for the proper overhauling of a car. 3000 w. *Automobile*—March 14, 1912. Serial. 1st part. No. 31172.

Commercial Vehicles

Motor Delivery in Gotham's Big Stores. Illustrated analysis of the automobile service systems in use in Gimbel Brothers' and the Greenhut-Siegel-Cooper establishments in New York City, N. Y. 4000 w. *Automobile*—March 21, 1912. No. 31461.

Design

Conditions of Least Weight for Petrol-Engines. Editorial discussion of the proportions likely to give the best results. 2000 w. *Engng*—Feb. 23, 1912. No. 31038 A.

On the Road. Owen John. Discusses the waste of space occupied by the bonnet, and suggests other desirable changes. 1600 w. *Autocar*—March 16, 1912. No. 31516 A.

Flanders

The 15-20 h. p. Flanders. Illustrated description of the 1912 models of this make. 1000 w. *Autocar*—March 9, 1912. No. 31243 A.

Lubricants

Castor Oil for Engine Lubrication. Alexander Duckham. A criticism of this oil as a lubricant, showing that in internal combustion engines it must be used with discretion. 1200 w. *Autocar*—March 9, 1912. No. 31244 A.

Military

The New Army Trucks (Der Neue Armee-lastzug). Fritz Listemann. Specifications for new types of German military automobiles. 3600 w. *Motorwagen*—Feb. 10, 1912. No. 31314 D.

Motor Valves

Noiseless Motor Valves (Der Geräuschlose Ventilmotor). Hubert Schimpf. Description of the operation and efficiency of these types. Diagrams. 2700 w. *Zeit d Mitt Motorwagen Ver*—Jan. 30, 1912. No. 31306 D.

Ordinances

The Street Ordinances of Berlin and the Automobile Traffic (Die Berliner Strassenordnung und der Automobilverkehr). Abstracts of such ordinances as relate to automobile traffic. 4000 w. *Zeit d Mitt Motorwagen Ver*—Jan. 30, 1912. No. 31305 D.

Phantomobile

The Phantomobile Car. Illustrations, description and impressions of a trial run. 2500 w. *Autocar*—March 16, 1912. No. 31517 A.

Shock-Absorbers

In the Making of Shock-Absorbers. Illustrates and describes the process of manufacture. 2000 w. *Automobile*—March 14, 1912. No. 31171.

Six-Cylinder Motors

Some Peculiarities of Six-Cylinder Motors. M. S. Young. Considers crankshaft arrangement, peculiar cause of vibration, etc. Ills. 2500 w. *Horseless Age*—March 6, 1912. No. 31055.

Starters

Self-Starters. J. Dalrymple Bell. Illustrated review of the present available systems. 4500 w. *Autocar*—March 2, 1912. No. 31130 A.

Tires

From Tree to Tyre. Considers rubber gathering and the processes of manufacture of tyres. Ills. 3500 w. *Autocar*—March 2, 1912. No. 31131 A.

Trucks

The Trend of the Times in Truck Work. Suggestions for improving their efficiency and increasing their economy. Ills. 3500 w. *Com Veh*—Feb., 1912. Serial. 1st part. No. 31008 C.

See also Auto Power under CIVIL ENGINEERING, Roads and Pavements.

Valves

Renewing Valve Seats and Replacing Valve Springs. Suggestions for the work, and for care of valve springs. 1500 w. *Auto Jour*—March 9, 1912. No. 31245 A.

COMBUSTION MOTORS

Gas Combustion

Surface Combustion. Raymond C. Benner. Remarks on the experimental work of W. A. Bone, and an application of this method of heating. Ills. 1600 w. *Min & Sci Pr*—March 2, 1912. No. 31064.

Gas Engines

Increasing the Capacity of Large Gas Engines. F. E. Junge. Gives a summary of results of an investigation by Wilhelm Hellmann, in Germany. Ills. 3500 w. *Power*—March 19, 1912. No. 31237.

The Bituminous Gas Engine in South Africa. Illustrated description of the bituminous gas plant at the Groenfontein tin mines. 1700 w. Engr, Lond—March 8, 1912. No. 31268 A.

See also Internal Combustion Engines under MARINE AND NAVAL ENGINEERING.

Gas Turbines

The Gas Turbine. Norman Davey. Reviews historical facts relating to steam turbines, and begins a discussion of gas turbines, indicating types possible, and pointing out those likely to give reasonable efficiency; the difficulties are explained and suggestions given. Ills. 3000 w. Engr, Lond—March 8, 1912. Serial. 1st part. No. 31261 A.

Motive Powers

Comparison of Gas, Oil and Steam Motive Powers. R. E. Mathot. Gives a comparison of installation costs, labor, fuel, etc. 1400 w. Power—March 5, 1912. No. 31002.

Oil Engines

Notes on Two-Cycle Oil Engines. Frank Duncanson. Read before the Inst. of Metals. Discusses the requirements, the disadvantages to be overcome, the advantages claimed, etc., over four-cycle engines. 2000 w. Mech Engr—March 1, 1912. No. 31141 A.

Diesel Engines at the Turin Exhibition. Illustrated descriptions of engines constructed by Sulzer Brothers. 2000 w. Engrg—March 8, 1912. No. 31259 A.

Test of a Kerosene Burning Oil Engine. Jasper Raymond Rand. Describes the engine and method of conducting the test. 2000 w. Sib Jour of Engrg—Feb., 1912. No. 31442 C.

The Junkers Engine. Illustrated description of this high-power oil motor. 1800 w. Sci Am Sup—March 2, 1912. No. 30930.

Preheating

The Effect of Water Vapor in Promoting Combustion. Reviews a paper by James A. King, read before the Am. Soc. of Agri. Engrs., explaining the action. 3000 w. Eng News—March 28, 1912. No. 31634.

Perfecting Internal Combustion Motors by Preheated Air (Perfectionnement des moteurs a combustion interne par le réchauffage préalable de l'air). A. Mouguier. Stating the principles of preheating, and some practical results obtained. Diagrams. Serial. 1st part. 3800 w. Genie Civil—Feb. 24, 1912. No. 31409 D.

HEATING AND COOLING

Air Conditioning

Air-Conditioning Apparatus—Principles Governing Its Application and Operation. Willis H. Carrier and Frank L. Busey. Illustrates and describes apparatus employed and information concerning applications and operation. 900 w.

Dom Engrg—March 2, 1912. Serial. 1st part. No. 30988.

Dust

Dust in Relation to Heating. Konrad Meier. Considers causes of vitiation and means of prevention, and some unsanitary practices resulting from hot-air systems. 3500 w. Heat & Vent Mag—March, 1912. No. 31562.

Federal System

The Federal Heat Unit at Work. Explanation of the Federal System of heating and ventilation, intended for use in connection with warm-air furnaces. 2000 w. Heat & Vent Mag—March, 1912. No. 31561.

Hotel Plant

Heating and Ventilating System of the Ritz-Carlton Hotel, N. Y. Charles A. Fuller. Brief illustrated description. 2000 w. Power—March 19, 1912. No. 31238.

Hot-Water Heating

Auxiliaries for Hot-Water Heating. J. J. Wilson. Read before the Am. Soc. of Heat. and Vent. Engrs. Illustrates and describes devices used to increase pressures to obtain higher temperatures. 1400 w. Met Work—March 8, 1912. No. 31052.

Ice Plants

See Combination Plant, under ELECTRICAL ENGINEERING, *Generating Stations*.

Plumbing

Plumbing in a Municipal Laundry and Bath. Illustrates and describes the provisions for water supply and drainage. 1500 w. Met Work—March 1, 1912. No. 30932.

Refrigeration

The Value of Insulation. Charles H. Herter. Considers the value of insulation in terms of refrigeration saved. 2000 w. Ice & Refrig—March, 1912. No. 31005 C.

Vacuum Heating

Air-Line Vacuum Heating for Dwellings. Illustrates and describes an application of this system in connection with low pressure steam heating for residence work. 1200 w. Met Work—March 1, 1912. No. 30933.

Ventilation

Ventilation of Office Buildings. Charles L. Hubbard. Outline of principles for general application and description of ventilating system in a Boston tall office building. Ills. 1500 w. Met Work—March 15, 1912. Serial. 1st part. No. 31200.

Air Passage in Ventilation Pipes (Sur l'écoulement de l'Air dans les Conduites de Ventilateurs). Ch. Reignier. Studies on the compression of air in forced ventilation. Ills. and Diagrams. 4000 w. Technique Moderne—Feb. 15, 1912. No. 31395 D.

HYDRAULIC MACHINERY

Headgates

See same heading under CIVIL ENGINEERING, *Water Supply*.

Pipe-Line Surges

Waves in Long Hydraulic Pipes and Tunnels. Robert H. Smith. Describes conditions at the works on the Lontsch River, Switzerland, with abstract of a paper by Dr. Franz Präsil in *Schweizer Bauzeitung*, giving a full investigation of the problem. Ills. 3500 w. Engr, Lond—March 15, 1912. No. 31531 A.

Pumps

An Investigation of the Air Lift Pump. George Jacob Davis and Carl Robert Weidner. Describes and discusses investigations made for the purpose of supplying reliable data, from tests on pumps of commercial size and of various types. Ills. 167 pages. Bul Univ of Wis—No. 450. No. 31289 N.

A Centrifugal Pump for Unscreened Sewage. Brief illustrated description of the Parsons "stereophagus" motor driven pump. 600 w. Eng News—March 14, 1912. No. 31185.

High-Speed Turbine Pumps. J. W. Rogers. Considers the advantages of the centrifugal over the reciprocating type of pump, the principles on which the centrifugal pump is based, and practical points bearing on the operation. Ills. 3000 w. Cassier's Mag—March, 1912. Serial. 1st part. 31189 B.

Two New 18,000,000-Gallon Units in New York's 98th Street Pumping Station. E. F. Walker. Doubling the pumping capacity without interfering with the delivery of water. Ills. 1500 w. Eng Rec—March 9, 1912. No. 31087.

Theory and Computations on the Tesla Centrifugal Discs (Theorie und Berechnung der Tesla-Kreisräder). H. Lorenz. Calculations on the propulsive force of the recently invented Tesla turbine pumps. Ills. Serial. 1st part. 1600 w. Zeit f d Ges Turbinenwesen—Feb. 29, 1912. No. 31308 D.

Turbine Regulation

The Influence of Bored-Out Feed Piping Upon Turbine Regulation (Der Einfluss geschlossener Wasserzuleitungen auf die Turbinenregelung). D. Thoma. Mathematical discussion. 3200 w. Die Turbine—March 5, 1912. No. 31347 D.

When Will a Regulator Work Invariably (Wann wird ein Regulator schwankungslos arbeiten)? Albert Hoepfener. Mathematical treatise aiming to work out an elimination of oscillations in turbine regulators. Diagrams. Serial. 1st part. 2800 w. Die Turbine—Feb. 5, 1912. No. 31304 D.

Turbines

Computations on the Friction of Liquids in the Inlet and Outlet Pipes and Chambers in Turbines and Pumps and Its

Effect Upon Efficiency (Die Berechnung der Flüssigkeitsreibung in Saugrohren, Düsen und Zellen von Turbinen und Pumpen und deren Einfluss auf den Wirkungsgrad). Victor Kaplan. Mathematical discussion with diagrams. Serial. 1st part. 1600 w. Zeit f d Ges Turbinenwesen—Feb. 29, 1912. No. 31309 D.

Turbine Tests

Tests on Pressure Variations in the Inlet Pipes on a Francis Turbine Under Overload Conditions (Versuche über die Druckänderungen in der Rohrleitung eine Francis-Turbinenanlage bei Belastungsänderungen). A. Watzinger and O. Nissen. Description of plant and conditions of overcharge, and the results. Ills. Serial. 1st part. 3300 w. Zeitschr des Ver deutscher Ing—Feb. 10, 1912. No. 31357 D.

Tests on Free Jet Turbines With the Aid of Pilot Tubes (Versuche an Freistrahlturbinen mit Hilfe der Pitotschen Röhre). Abstracts from a paper by Wm. R. Eckart on "The Application of the Pilot Tube to the Testing of Impulse Water-Wheels," delivered before the Institution of Mechanical Engineers. Ills. Serial. 1st part. 1600 w. Zeit f d Ges Turbinenwesen—Feb. 10, 1912. No. 31307 D.

MACHINE ELEMENTS AND DESIGN

Flywheels

The Design of Cast Iron Flywheels. F. A. Halsey. A summary of present knowledge and practice. Ills. 1500 w. Am Mach—March 28, 1912. No. 31540.

Selection of Motors and Flywheels. C. R. Riker and S. A. Fletcher. Gives a series of curves by means of which the constants for any ordinary flywheel can be determined. Explains their use and limitations. 5000 w. Am Mach—March 7, 1912. No. 31070.

Gyroscopes

Gyroscopic Effects (Effets Gyroscopiques). G. Clauzel. A study of the fundamental principles of the gyroscope, and considerations for its practical utility. Diagrams. Serial. 1st part. 14400 w. Rev de Mécanique—Jan., 1912. No. 31391 E + F.

See also Compasses, under MARINE AND NAVAL ENGINEERING.

Vise Jaws

The Designing of Machine Vise Jaws. Lucian L. Haas. Considers the many different styles of vises, all showing the necessity of rigid construction. Ills. 1200 w. Am Mach—March 7, 1912. No. 31073.

MACHINE WORKS AND FOUNDRIES

Boring Machine

A New Boring Machine for Extra Heavy Work. Illustrated description of a new tool, showing the tendency toward all gear drive and high power. 1500 w. Ir Trd Rev—Feb. 29, 1912. No. 30945.

Brass Founding

The Industrial Melting of Metals by Gas. Particulars of work done in brass foundries where the gas is at an augmental pressure and the air normal. 600 w. Engng—March 1, 1912. No. 31149 A.

Briquetting

Iron and Steel Briquettes in Foundry Work (Eisen- und Stahlbriketts im Giesereibetrieb). Hugo Fürth. Discusses the present practice. Serial 1st part. 1600 w. Giesserei Zeitung—Feb. 15, 1912. No. 31301 D.

Bronze Founding

The History of Bronze Founding in Ancient Times (Die Geschichte der Bronze giesserei der alten Welt). Hugo Kühl. The use of bronze among the ancients and its composition. Serial. 1st part. 1400 w. Giesserei Zeitung—Feb. 15, 1912. No. 31303 D.

Case-Hardening

Studies on the Gas Liberated by Cements (Étude sur les Gaz dégagés par les Cements). H. de Nolly and L. Veyret. Researches in determining the cause of violent eruptions of inflammable gas produced in course of cementation. Ills. 4500 w. Rev de Métallurgie—Feb., 1912. No. 31392 H.

Castings

Practical Hints on Moulding and Casting Aluminium. From *Foundry Trades Jour.* Hints for moulding, gating and melting. 1600 w. Mech Engr—March 8, 1912. No. 31255 A.

Gas Cavities, Shot and Chilled Metal in Iron Castings. Thomas D. West. Expert testimony on their causes and cures. 7000 w. Castings—March, 1912. No. 31273.

Casting Aluminium. Walter J. May. Explains methods necessary to secure satisfactory work. 1500 w. Prac Engr—March 1, 1912. No. 31139 A.

Technical Development Shown from the Recovery of Cast Iron Oven Plates (Die technische Entwicklung der Herstellung gusseiserner Ofenplatten). Otto Johnsen. Illustrating the developments in the science of casting from 16th Century oven plates. Ills. 3800 w. Stahl u Eisen—Feb. 29, 1912. No. 31322 D.

Core Boxes

Cores and Core Boxes of a Pipe Fittings Specialty Plant. J. J. Metzgar, Jr. Detailed description of core-room practice in a plant producing large quantities and great variety. Ills. 2000 w. Castings—March, 1912. No. 31272.

Die-Casting

Automatic Die-Casting Machines. E. F. Lake. Illustrated, detailed descriptions of types. 3000 w. Mach, N Y—March, 1912. No. 30925 C.

Drills

Manufacture of Lincoln-Williams Twist Drills. Chester L. Lucas. Illustrates

and describes interesting operations in connection with this work. 2500 w. Mach, N Y—March, 1912. No. 30921 C.

A Remark on the Subject of Twist-Drill Sharpening (Ein Beitrag zum kapitel "Spiralbohrerschleifen"). Hans Volkmann. Notes and diagrams on the theoretical and practical ways of sharpening drills. Ills. Serial. 1st part. 3600 w. Zeitschr f Werkzeugmaschinen und Werkzeuge—March 5, 1912. No. 31349 D.

Foundry Practice

Foundry Melting and Mixing. David M'Lain. From a paper before the Pittsburgh Found. Assn. An account of early experience with semi-steel mixtures, showing the importance of cupola management. 4000 w. Ir Age—March 14, 1912. No. 31165 C.

Results From Ventilators and Blowers (Wirkung von Ventilatoren und Kapselgebläsen). Georg Lindner. Mathematical determination of the relative effects from the two kinds of draft. 3150 w. Giesserei Zeitung—Feb. 15, 1912. No. 31302 D.

Mechanical Appliances and Materials in the Foundry (Matériel et Outillage Mécanique de la Fonderie). L. Descroix. A review of British and French practice. Ills. Serial. 1st part. 3000 w. Technique Moderne—March 1, 1912. No. 31398 D.

Furnaces

The Operation of Small Open-Hearth Furnaces. B. H. Reddy. Illustrates and describes various types of fuel-oil burners with the arrangement of the burner port. 3500 w. Foundry—March, 1912. No. 30957.

Galvanizing

The Sherardizing Process. Thomas Liggett, Jr. Read before the Phila. Found. Assn. An account of the process, with information concerning the durability of the coating, testing, etc. 2200 w. Foundry—March, 1912. No. 30955.

Galvanizing. Louis Potthoff. Read before the Nat. Electroplaters' Assn. Illustrated description of the electro-galvanizing process and plants. 2500 w. Brass Wld—March, 1912. No. 31446.

Grinding

Efficiency in Cylindrical Grinding. F. B. Jacobs. Considers methods employed for obtaining the maximum output from the grinding machine. 2000 w. Mach, N Y—March, 1912. No. 30919 C.

Jigs

Uses and Advantages of the Latch Jig. J. N. Bethel. Explains its adaptability for the rapid production of interchangeable parts. Ills. 800 w. Am Mach—March 21, 1912. No. 31277.

Lathes

Cutting Force, Supporting Power and Drive on Lathe Work (Schneidkraft, Supportanlage und Antriebe an Drehbänken). Georg Lindner. Calculations

for the determination of these forces. Ills. Serial. 1st part. 4500 w. Zeitschr f Werkzeugmaschinen u Werkzeuge—Feb. 5, 1912. No. 31348 D.

Milling

Modern Machine Shop Milling Processes. Charles S. Gingrich. Illustrates and describes milling processes as applied to the column and knee type of machine, illustrating three systems of continuous milling. 4400 w. Jour Cleveland Engng Soc—March, 1912. No. 31571 D.

Molding

Improvements in Hinged Match-Plate Work. Illustrates and describes the practice of a Canadian stove plate foundry employing labor-saving molding devices. 2500 w. Foundry—March, 1912. No. 30953.

Planers

Planing Machines. An illustrated discussion of rack-driven and screw-driven machines, methods of driving and reversing, etc. 2500 w. Prac Engr—Feb. 23, 1912. Serial. 1st part. No. 31022 A.

Pneumatic Tools

Applications for Pneumatic Tools. Illustrates and describes a few of the uses to which they have been applied. 1500 w. Mach, N Y—March, 1912. No. 30927 C.

Presses

Making a Clip in the Punch Press. E. A. Suverkrop. Illustrates and describes the various operations in making a clip from a single piece of brass. 800 w. Am Mach—March 28, 1912. No. 31539.

Shop Design

Factory Construction and Arrangement. Discussion of a paper by L. P. Alford and H. C. Farrell. 6500 w. Jour Am Soc of Mech Engrs—March, 1912. No. 31569 D.

Shop Lighting

See same heading, under ELECTRICAL ENGINEERING, *Lighting*.

Shop Practice

Drawing a Flanged and Tapered Cylindrical Shell. Joseph V. Woodworth. Illustrated description of the successive operations and the tools used. 1200 w. Mach, N Y—March, 1912. No. 30918 C.

Milling Axial Teeth in Cutter and Reamer Blanks. George W. Burley. Explains an exact method of determining the depth of the cut required for any given conditions. Supplement. 1200 w. Mach, N Y—March, 1912. No. 30920 C.

Magazine Work on Screw Machine. S. Nevin Bacon. Illustrated description of work requiring assembling of two or more pieces, accomplished with the aid of magazine attachments on screw machines. 2500 w. Am Mach—March 7, 1912. No. 31072.

Methods of an English Motor Shop. I. W. Chubb. Illustrates and describes methods employed in the manufacture of

4-cylinder 15 h. p. motors. 3000 w. Am Mach—March 14, 1912. No. 31125.

A Kansas City Automobile Factory. F. A. Stanley. Illustrates and describes special tools used. 1500 w. Am Mach—March 28, 1912. No. 31538.

Machining Locomotive Frames. Franklin D. Jones. Illustrates and describes the practice at the Juniata shops of the Pennsylvania R. R. 4500 w. Mach (Ry Ed)—March, 1912. No. 31095 C.

Methods in the "Katy" Railway Shops. F. A. Stanley. Half-tones, line engravings and description of methods used. 1500 w. Am Mach—March 21, 1912. No. 31275.

Problems

Shop Problems Involving Gear and Pulley Speeds. J. H. Carver. Discusses problems likely to occur in ordinary shop practice, giving solutions. Ills. 1200 w. Mach, N Y—March, 1912. No. 30924 C.

Shops

The New Plant of the Cincinnati Milling Machine Co. Illustrated detailed description of the plant at Oakley, Cincinnati. 3500 w. Mach, N Y—March, 1912. No. 30926 C.

A Modern Colorado Machine Shop. Fred H. Colvin. Illustrates some of the special machines and devices used in building the Leyner rock drill. 1200 w. Am Mach—March 28, 1912. No. 31536.

Tools

Oil Groove Cutting Tool. Douglas T. Hamilton. Illustrated description of a turret tool for the Brown & Sharpe automatic screw machine. 1500 w. Mach, N Y—March, 1912. No. 30922 C.

Phonograph Machines and Devices. Ethan Viall. Illustrates and describes tools used in the production of phonograph parts. 2000 w. Am Mach—March 28, 1912. No. 31537.

Tools for Adding Machine Work. F. A. Stanley. Illustrates and describes interesting press tools for special work. 2500 w. Am Mach—March 14, 1912. No. 31126.

Heavy Driller in Automobile Work. Illustrated description of methods and tools used in machining automobile cylinders and brake support forgings on modern high-power drillers. 1000 w. Am Mach—March 14, 1912. No. 31127.

Special Tools Used in the Making of Dental Chairs. Carroll Ashley. Briefly describes the construction of dental chairs, and the tools used in the making. Ills. 3500 w. Mach, N Y—March, 1912. No. 30917 C.

Welding

Electric Welding. O. S. Beyer, Jr. Describes typical processes of electric welding, their applications especially in the railroad shop, explaining their possibilities and limitations. Ills. Also

general discussion. 12500 w. Pro N Y R R Club—Feb. 1, 1912. No. 31433.

Electric Welding. J. A. Shaw. From a paper before the Can. Ry. Club. Reviews briefly the various processes of electric welding, and some recent developments. Diagrams. 2500 w. Ry Mas Mech—March, 1912. No. 31222.

Oxy-Acetylene Welding and Cutting. J. A. Warfel. Descriptive account of work in this field, followed by general discussion by other members. Ills. 6000 w. Pro Ry Club of Pittsburgh—Jan. 26, 1912. No. 31297 C.

MATERIALS OF CONSTRUCTION

Alloys

Further Experiments on the Critical Point at 470 Deg. Cent. in Copper-Zinc Alloys. H. C. H. Carpenter. Read before the Inst. of Metals. A report of research work and study of this alloy, with photomicrographs showing its appearance. 5000 w. Engng—Feb. 23, 1912. No. 31043 A.

A New Alloy of High Tensile Strength. C. Vickers. Information concerning chromax bronze. 1500 w. Foundry—March, 1912. No. 30956.

The Practical Determination of the So-Called "Formation" Diagram of Metallic Alloys for the Foundry Expert (Die praktische Bedeutung der sogenannten Zustandsdiagramme der Metallegierungen für den Giessereifachmann). W. Guertler. A study of the metallography of alloys. Ills. Serial. 1st part. 6000 w. Giesserei-Zeitung—March 1, 1912. No. 31371 D.

Aluminum

Aluminum in the Brewing Industry. C. Bleisch. An account of its use for fermenting, storage vessels and other parts. 2500 w. Sci Am Sup—March 30, 1912. No. 31647.

The Manufacture of Aluminum Paper and Powder (La Fabrication du Papier et de la Poudre d'Aluminium). Leon Guillet. Description of the mechanical appliances at two French plants for the production of this novel material. Ills. 6000 w. Rev de Metallurgie—March, 1912. No. 31403 H.

Brass

Brass: Its Manufacture and Practical Applications. J. J. Edwards. Lecture delivered before the Lond. and Dist. Branch of the British Found. Assn. Information concerning methods and utilization. 3000 w. Mech Engr—Feb. 23, 1912. No. 31027 A.

Bronze

Experiments on the Wear of Bronzes (Essais sur l'Usure des Bronzes). Mm. Portevin and Nusbaumer. With reference to bronzes of differing chemical compositions with photomicrographs. Ills. 7000 w. Rev de Metallurgie—Feb., 1912. No. 31393 H.

Corrosion

Summary of Corrosion Tests of Wrought Iron and Steel. Gives a summary of early and of later tests, with results. 1500 w. Boiler Maker—March, 1912. No. 31115.

Wrought Iron, Steel and Corrosion. William R. Fleming. A study in differences of chemical and physical properties and their relation to variations in service. Ills. 2500 w. Ir Age—March 14, 1912. No. 31164 C.

Fire Bricks

The Formation of Dinas Fire Brick (Ueber die Konstitution der Dinassteine). Kurd Endell. A structural analysis of various of these formations. Ills. 3500 w. Stahl u Eisen—March 7, 1912. No. 31340 D.

Hammered Metals

Leaf-Metal Processes in Ancient and Modern Times (Die Herstellung des Blattmetalls in Altertum und Neuzeit). W. Theobald. A descriptive review of ancient and modern methods of producing hammered metals. This first article treating on methods employed among the early Egyptians, Japanese, Indian, Romans and Grecians. Ills. Serial. 1st part. 7500 w. Glaser's Annalen—March 1, 1912. No. 31346 D.

Rivets

Steel Rivets. D. J. Champion. Read before the Am. Boiler Mfrs. Assn. Practical suggestions for users. 2000 w. Ir Age—March 28, 1912. No. 31595 C.

See also Rivetting, under CIVIL ENGINEERING, *Construction*.

Rubber

Rubber. Dr. W. C. Gear. Considers crude rubber, vulcanization, raw materials, articles and methods of manufacture, specifications, etc., with discussion. Ills. 5000 w. Jour Cleveland Engng Soc—March, 1912. No. 31573 D.

Scrap

The Conservation of Material. Ernest Cordeal. Describes methods which resulted in a saving of about 30 per cent. 1600 w. Am Engr—March, 1912. No. 31057 C.

Steels

Iron and Steel for Electrical Appliances. Gives an outline of the present conditions of the magnetic properties of iron and steel, and particulars of results already obtained. 1700 w. Mech Wld—Feb. 23, 1912. No. 31030 A.

See also same heading, under CIVIL ENGINEERING, *Materials of Construction*.

Tool Steel

Structure and Heat Treatment of Tool Steel. J. V. Emmons. Read before the Metal Trds. Supts. & Foremen's Club of Cleveland. Considers elements present and their effects, methods of inspection, annealing, hardening, etc. Ills. 3500 w. Mech Engr—March 8, 1912. No. 31254 A.

MEASUREMENT

Gages

Manufacturing Plug Gages at Low Cost. J. P. Brophy. Gives the system of making the cost and methods of the Cleveland Automatic Machine Co. Ills. 2500 w. Am Mach—March 21, 1912. No. 31276.

Laboratories

A Late Mechanical Engineering Laboratory. Ellsworth Tonkin. Illustrates and describes arrangements and equipment at Ohio State University for testing materials and hydraulic, ventilating and steam and gas power plant apparatus. 1600 w. Ir Age—March 7, 1912. No. 31053 C.

The Hydraulic and Mechanical Laboratories of the University of Toronto, Toronto, Canada. Robert W. Angus. Deals with these laboratories and their work. Ills. 3000 w. Engng—Feb. 23, 1912. Serial. 1st part. No. 31033 A.

Historic and Descriptive Sketch of the Experimental Hydraulic Laboratory at Santhia (Cenni storici e descrittivi della Stazione Idrometrica sperimentale di Santhia). Carlo Mazzini. Review of the work at this station since its erection in 1868. Ills. 10000 w. Ann della Soc d Ing e d Arch Ital—Jan. 16, 1912. No. 31420 E.

Levelling

Precise Levelling in Workshop Practice. G. H. Millar. Explains two methods found very useful in certain cases. Ills. 1200 w. Engng—March 1, 1912. No. 31145 A.

Lubricant Testing

The Outerbridge Method of Detecting Mineral Oils and Resin Oil in Other Oils. Extracts from Mr. Outerbridge's paper read before the Am. Soc. for Test Materials, with colored plate. 2500 w. Am Found Assn—Vol. XX., 1912. No. 31639 N.

Metal Testing

The Optical Properties of Metals. L. R. Ingersoll. Illustrated study from the standpoints of theory and experiment. 4500 w. Sci Am Sup—March 30, 1912. No. 31649.

Micrometers

Some Uses of the Micrometer. George W. Burley. Explains the value of this precision tool and describes uses to which it can be applied. Diagrams. 1800 w. Mech Wld—Feb. 23, 1912. Serial. 1st part. No. 31028 A.

Rating

The Rating of Machinery. Discusses the present position in England, and the law on this subject. 3000 w. Engr, Lond—Feb. 23, 1912. No. 31047 A.

Stress

An Experimental Lecture on "Colour: Its Production and Its Application to the Determination of Stress." James Muir. Discusses colour effects and their causes, and their application to the

measurement of stress. 4000 w. Trans Inst of Engrs & Shipbldr in Scotland—Feb. 13, 1912. No. 31654 N.

Testing Machines

Testing Machine of 3000-Ton Power for Iron Construction Parts (Prüfungsmaschine von 3000 t. Druckkraft für Eisenkonstruktionsteile). Details of large testing machine at Gross-Lichterfeld. Ills. 1700 w. Stahl u Eisen—March 7, 1912. No. 31341 D.

Torsion

Tests on Square Rods Under Torsion, and Researches on the Lineal Expansion and Sectional Contraction on Rods Under Tension (Versuche über der Verdrehung von Stäben mit rechteckigem Querschnitt und zur Ermittlung der Längs- und Querdehnung auf Zug beanspruchter Stäbe). O. Bretschneider. Mathematical discussion. Ills. 7200 w. Zeitschr des Ver deutscher Ing—Feb. 17, 1912. No. 31361 D.

POWER AND TRANSMISSION

Air Compressors

Large Synchronous Motors for Compressor Service. G. B. Rosenblatt. Considers the policy of centralizing air compressor stations in mining, the selection of electrical apparatus, and describes one of the largest stations employing such motors. Ills. 2500 w. Elec Jour—March, 1912. No. 31597.

Auxiliary Plant

Some Considerations on the Choice of Auxiliary Plant for Power Stations. A. H. Finch. Considers points of importance in the design of an auxiliary system. Discussion. Ills. 10500 w. Trans N-E Coast Inst of Engrs & Shipbldr—March, 1912. No. 31652 N.

Belts

Experiments on Special Belting (Versuche mit Riemen besonderer Art). Herr Kammerer. Results of tests on articulated, leather, woven, and other belts. Ills. 6000 w. Zeitschr d Ver deutscher Ing—Feb. 10, 1912. No. 31356 D.

Composite Plants

Combination Power and Ice Plant. Paul C. Percy. Brief illustrated description of a doubly composite plant at Waycross, Ga., in which both steam and gas are motive powers and the products are ice and electricity. 1200 w. Power—March 26, 1912. No. 31512.

Electric Power

Electric Power and Heating in Candy Manufacturing. Discusses the cost of steam and electric power, gives power requirements, and illustrates and describes typical electrical installations. 3500 w. Elec Rev & W Elect'n—March 9, 1912. No. 31108.

Motor Drive in Sewing Machine Factory. Guy R. Grove. Illustrates and describes an up-to-date installation for a medium-size manufactory. 1500 w. Elec

Rev & W Elect'n—March 9, 1912. No. 31109.

See also Cement Mills, under MINING AND METALLURGY, *Minor Minerals*.

Grinding Mill

The Jackson-Gardner Vertical Grinding Mill and Huller. Illustrated description. 500 w. Engng—Feb. 23, 1912. No. 31044 A.

Lubrication

A Theoretical and Experimental Study of Mediate Friction. Prof. N. Petroff. A mathematical study. 2000 w. Engr, Lond—March 8, 1912. Serial. 1st part. No. 31264 A.

Power Plants

An Interesting Power System. C. A. Tupper. Brief description of an interesting combination of two steam-turbine plants, one using sawmill refuse for fuel, and the other using exhaust steam supplied by the first plant. Ills. 800 w. Power—March 19, 1912. No. 31234.

Rope Driving

Transmitting Power by Ropes. Everard Brown. Brief description of the systems used, the calculation of power, etc. 1500 w. Power—March 12, 1912. No. 31121.

STEAM ENGINEERING

Boiler Design

Notes on the Design of Cylindrical Tanks and Boilers. F. A. Garrett. Briefly describes the principles which govern the design, and discusses the relative efficiencies of riveted joints. 1000 w. Boiler Maker—March, 1912. No. 31113.

Boiler Explosions

The Causes of Boiler Explosions. S. F. Jeter. Read before the Am. Boiler Mfrs. Assn. Considers faulty design and carelessness to be the chief causes of disaster. 2500 w. Power—March 26, 1912. No. 31514.

Boilers

The Vulcan Flexible System of Staying for Lancashire Boilers. Illustrated description. 1500 w. Boiler Maker—March, 1912. No. 31114.

On the Wider Adoption and Standardization of Water-Tube Boilers. E. M. Speakman. Read before the Inst. of Engrs. & Shipbldrs. in Scotland. Discusses reasons for and against their wider adoption, types, etc. Ills. 1800 w. Engr, Lond—March 1, 1912. Serial. 1st part. No. 31154 A.

Boiler Water

Mechanical Water Softener. Illustrated description of an important adjunct for boiler plants, used in England. 1000 w. Sci Am Sup—March 16, 1912. No. 31170.

Condensers

Condensers for the Power Plant. William F. Fischer. Gives a general classification, describing various types and their operations. 2500 w. Power—March 19, 1912. No. 31236.

Draft

Relative Economy of Various Types of Draft Equipment. T. F. J. Maguire. Second of three articles, discusses induced mechanical draft from the standpoint of economy. Ills. 4000 w. Engineering Magazine—April, 1912. No. 31548 B.

Engines

The Development of the Steam Engine. August Sinclair. Brief review of developments up to about 1770. Ills. 2000 w. Ry & Loc Engng—March, 1912. No. 30949 C.

An Important Development of the Steam Engine. Warren H. Miller. Illustrated description of the German "locomobile," or superheated steam unit. 2500 w. Sci Am—March 9, 1912. No. 31074.

Feed-Pumps

Report of Test of a Boiler Feed Pump of Boston Navy Yard Design, at the Engineering Experiment Station, Annapolis, Maryland. An account of test made to determine the efficiency, water rate per I. H. P., slip and duty at different speeds, discharge pressure and temperatures of water handled. Ills. 1800 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31490 H.

Feed-Water Heaters

Test of a Feed Water Heater at the Naval Engineering Experiment Station, Annapolis, Maryland. Test to determine the B. T. U. transmitted per sq. ft. of heating surface per hour, under varying conditions. Ills. 2500 w. Jour Am Soc of Nav Engrs—Feb., 1912. No. 31494 H.

Fuel Purchasing

A Proposed Basis for Coal Purchase. John P. Cosgro. Explains a proposed system. 1500 w. Power—March 12, 1912. No. 31123.

The Economy to the Consumer Resulting from the Purchase of Coal Under Specifications. W. O. Collins. From a paper read before the Illinois Water Supply Assn. 3000 w. Engng & Con—March 27, 1912. No. 31619.

Fuels

The Gasification of Fuel. Charles Edward Lucke. This fourth part of a serial considers progress in producer design, giving constructive suggestions. Ills. 5500 w. Engineering Magazine—April, 1912. No. 31553 B.

Fuel Tests

Steaming Tests of Coals and Related Investigations. Sept. 1, 1904, to Dec. 31, 1908. L. P. Breckenridge, Henry Kreisinger and Walter T. Ray. Gives the history and object of the fuel-testing plant, with an analytical study of the tests. 380 pages. U S Bureau of Mines—Bul 23. No. 31610 N.

Smoke Prevention

Economic Aspects of the Smoke Nuisance. John A. Switzer. Shows that

smoke abatement is a measure of economy. Ills. 3000 w. Sci Am Sup—March 9, 1912. No. 31076.

Steam Economy

Economy in the Use of Steam. R. H. Rowland. Considers various ways of economizing steam. 2200 w. Mines & Min—March, 1912. No. 30968 C.

Turbines

Low Pressure Turbine Installation. B. R. T. Collins. Shows the saving effected by installing a 1500-Kw. low-pressure turbo-generator in connection with a non-condensing Corliss engine. 1500 w. Power—April 2, 1912. No. 31710.

Heat Drop in Steam Turbines. Thomas B. Morley. Calls attention to an erroneous use of language common to many workers on steam turbine theory and design. 1200 w. Engr, Lond—March 8, 1912. No. 31263 A.

The Critical Speed of Turbine Shafting. Explains the theory of critical speeds and the calculation. 1200 w. Prac Engr—March 22, 1912. Serial. 1st part. No. 31721 A.

TRANSPORTING AND CONVEYING

Aerial Tramways

A Remarkable Aerial Ropeway. Illustrates and describes a recent construction for some tin mines in Bolivia, three miles above sea level. 700 w. Engr, Lond—March 1, 1912. No. 31155 A.

Argentine Government Aerial Tram. C. A. Tupper. Illustrated description of the government owned line extending from Upusungos to Chilecito, a distance of about 22 miles, with a difference in elevation of 11,574 feet. 2500 w. Eng & Min Jour—March 23, 1912. No. 31476.

Construction of Argentine Tram. C. A. Tupper. Illustrates and describes features of interest in the construction of this tramway in the Argentine Republic. 2000 w. Eng & Min Jour—April 6, 1912. No. 31825.

See also Plants, under MINING AND METALLURGY, *Mining*.

Cableways

An African Freight Cableway. C. A. Tupper. Illustrated description of a cableway in German East Africa to transport valuable timber from the Usambara Mts. 2000 w. Eng News—Feb. 29, 1912. No. 30935.

Coal Handling

Notes on the Use of Alternating Current in Unloading Coal. W. N. Ryerson and J. B. Crane. Illustrated detailed description of the unloading equipment at the docks in Duluth-Superior harbor, and the operation. 4500 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31580 F.

Conveyers

Notes on the Use of Belt Conveyers. John J. Ridgway. Considers practical

matters affecting the efficiency. 2000 w. Power—March 19, 1912. No. 31235.

Cranes

Electrically Operated Locomotive Cranes. L. F. Grant. Illustrates and describes types. 800 w. Elec Jour—March, 1912. No. 31604.

200-Ton Electric Revolving Cantilever Crane. Illustrated detailed description of the crane at Kure, for the Imperial Japanese navy. Plate. 2000 w. Engng—March 15, 1912. No. 31528 A.

Derricks

A Forty-Ton Floating Derrick. Illustrates and describes details of a derrick recently put in service on construction work in Cuba. 800 w. Eng Rec—March 2, 1912. No. 30987.

Electrical Machinery

Electrical Equipment for Hoisting and Conveying Machinery (Elektrische Ausrüstungen auf Hebe- und Transportmaschine). W. Vogel. General specifications for the necessary equipment for any kind of transporting machine. 2000 w. Elek Kraft u Bahnen—Feb. 24, 1912. No. 31369 D.

Elevators

The "Paternoster" Continuous Elevator (Ascensori a movimento continuo, O ascensori "Paternoster"). U. Quintavalle. An endless chain elevator with several compartments. Ills. 2500 w. L'Industria—March 10, 1912. No. 31422 D.

The Action of the Stiegler Elevator (Disposition des Ascenseurs Stiegler). Rod. Escher. Presenting the action and arrangement of this hydraulic elevator. Ills. 4500 w. Alliance Industrielle—March, 1912. No. 31416 D.

Package-Handling

The Package-Handling System at the New American Express, New York. Illustrated description of labor-saving facilities and plan of operation at the new terminal just west of the Penn. station. 2500 w. Eng Rec—March 30, 1912. No. 31655.

MISCELLANY

Brick Machinery

Building a Brick-Making Machine. C. A. Rogers and Lloyd Smith. Illustrated description of a machine having a capacity of 40,000 bricks per day. 1500 w. Am Mach—March 21, 1912. No. 31278.

The Brick Industry in Italy (L'Industria laterizia in Italia). Review of labor conditions, plants and machinery in Italian brick making. Serial. 1st part. 2500 w. Il Cemento—Jan. 15, 1912. No. 31413 D.

Gas Works

The New Gas Plant at Lausanne (La nouvelle usine à gaz de la ville de Lausanne, à Malley). W. Cornaz. General description of this plant and its construction. Ills. Serial. 1st part. 3100 w.

Bul Tech d l Suisse Romande—Feb. 25, 1912. No. 31394 D.

Guns

The Davis Gun-Torpedo. Illustrated description of the gun-torpedo designed by Com. Cleland Davis, and report of result of tests made by the U. S. Government. 1200 w. Engr, Lond—Feb. 23, 1912. No. 31048 A.

Phonographs

Making Edison Phonographs. Ethan Viall. Illustrates and describes details of shop practice. 2000 w. Am Mach—March 7, 1912. No. 31068.

Sugar Mill

A Large Sugar Mill. Illustrated description of a 14-roller milling plant, with rollers 40 in. in diameter and 84 in. long, for an installation in Argentine Republic. 1500 w. Engr, Lond—March 1, 1912. No. 31153 A.

Vacuum Cleaners

Tests of Portable Vacuum Cleaners. C. A. Pierce. Report of tests of ten

cleaners of various designs. 1800 w. Elec Wld—March 2, 1912. No. 30995.

Steam Consumed by Vacuum Cleaner. J. V. Hunter. Gives results of a test upon a steam-ejector type of vacuum cleaner, showing the steam consumption at different vacuums and loads. Ills. 2000 w. Power—March 5, 1912. No. 31001.

The Art of Vacuum Cleaning. Austin H. Hart. A practical discussion of present methods and appliances. 2000 w. Heat & Vent Mag—March, 1912. Serial. 1st part. No. 31563.

Waste Waters

The Waste Water in the Manufacture of Precious Metal Wares and the Determination of the Precious Metal Content (Die Abwasser der Edelmetallwarenfabriken und die Bestimmung des enthaltenen Edelmetals). A. Mahringer. Treating on the losses in the manufacture of platinum, gold and silverwares. Serial. 1st part. 1800 w. Elektrochem Zeitschrift—Feb., 1912. No. 31300 D.

MINING AND METALLURGY

COAL AND COKE

Analysis

Methods of Analyzing Coal and Coke. Frederic M. Stanton and Arno C. Fieldner. Describes the original methods and such modifications as experience has shown advisable. Ills. 5500 w. U S Bureau of Mines—Paper 8. No. 31291 N.

What Is Anthracite (Was ist Steinkohle)? Ed. Donath. An analysis of the characteristics and composition of anthracite. Serial. 1st part. 1800 w. Oest Zeitschr f Berg- u Huttenwesen—Feb. 10, 1912. No. 31326 D.

Austria

Anthracite Review of Rossitz, Zbeschau and Oslavania (Das Rossitz-Zbeschau-Oslavaner Steinkohlenrevier). Franz Franz. Geologic and analytic review of this coal field. Diagrams. Serial. 1st part. 2400 w. Oest Zeitschr f Berg- u Huttenwesen—Feb. 3, 1912. No. 31324 D.

Coal Deposits

The Geology of Coal. John Sim. Read at a meeting in the Roy. Tech. College, Glasgow. On the origin, the "in situ" and "drift" theories. 5500 w. Ir & Coal Trds Rev—March 8, 1912. No. 31269 A.

Coaldust

Coaldust in Mines. Dr. J. Harger. Abstract of paper read before the Liverpool Sec. of the Soc. of Chem. Ind. Discusses coaldust explosives, giving results of experimental work. General discussion. 2500 w. Col Guard—Feb. 23, 1912. No. 31031 A.

French Tests on Coal Dust at Liévin (Die französischen Versuche mit Koh-

lenstaub in Liévin). M. Rybák. Results of tests on the explosive liability of coal dust. Serial. 1st part. 2800 w. Oest Zeitschr f Berg- u Huttenwesen—Feb. 24, 1912. No. 31328 D.

Coal Fields

The Smokeless Coal Field of West Virginia. Edwin Ludlow. Discusses legal and business conditions which operate to promote the wasteful exploitation of coal lands. 2000 w. Mines & Min—March, 1912. No. 30967 C.

Extracts from Report on the Brule Lake Coal Claims. James McEvoy. Information concerning the geology, quantity and quality of the coal, method and cost of mining in this Canadian field. 4500 w. Can Min Jour—March 1, 1912. No. 31082.

Coke Ovens

A Few Points Concerning By-Product Coke Ovens. R. Gillon. Read before the S. Wales and Monmouthshire Br. of the Nat. Assn. of Col. Mgrs. Discusses the conditions to be fulfilled by by-product coke ovens. 3000 w. Ir & Coal Trds Rev—Feb. 23, 1912. No. 31050 A.

Electric Power

Central Station Power in Coal Mines. W. A. Thomas. Discusses the electrification of mines, the problems to be solved, and the applications, installation costs, etc. 5000 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31581 F.

Explosions

The Explosion in the Anthracite Coal Mine of the Radbod, 1 and 2, at Hamm (Wesphalia) on the 12th November, 1908

(Die Explosion auf der Steinkohlengrube Radbod I/II bei Hamm i. W. am 12 November, 1908). Herr Hollender. Description of the explosion, its probable cause and effects. Diagrams and plates. Serial. 1st part. 13500 w. Glückauf—Feb. 3, 1912. No. 31329 D.

Firedamp

The Estimation of Firedamp in Mines. F. K. Cartwright. Abstract of a paper read before the Yorkshire branch of the Nat. Assn. of Col. Mgrs., and of the discussion. Reports experiments leading to such estimation. 4000 w. Col Guard—March 15, 1912. No. 31535 A.

Germany

Germany's Coal Production and Export in 1911 (Kohलगewinnung und-aussenhandel Deutschlands im Jahre 1911). Comparative tables of the years 1910 and 1911, showing marked gain. 3500 w. Glückauf—Feb. 10, 1912. No. 31333 D.

Mine Timbering

Longwall Mining in Illinois. Illustrated description of the plan used in mines of Spring Valley Coal Co., the method of timbering, etc. 2000 w. Mines & Min—March, 1912. No. 30962 C.

Saskatchewan

Saskatchewan Fuels and Gas. R. O. Wynne-Roberts. Read before the Regina Soc. of Arts & Sciences. Gives information concerning the quantity and quality of available fuel. 3000 w. Can Engr—March 21, 1912. No. 31474.

Washing

Standardization in Coal Washing. George R. Delamater. A plea for uniformity in tests and reports, giving formulae for comparison of washery work. 5000 w. Mines & Min—March, 1912. No. 30966 C.

COPPER

Michigan

The Copper-Mining Industry of Michigan. Redinald E. Hore. Illustrated review of these copper mines and their development. 2500 w. Min & Engng Wld—March 16, 1912. Serial. 1st part. No. 31230.

Mineralization

Conditions of Mineralization in the Copper Veins at Butte, Montana. Charles T. Kirk. 16000 w. Ec Geol—Jan., 1912. No. 31192 D.

Ore Deposits

The Occurrence and Origin of Gypsum and Anhydrite at the Ludwig Mine, Lyon County, Nevada. Austin F. Rogers. Describes these deposits in occurrence with the copper ores. 1000 w. Ec Geol—Feb.-March, 1912. No. 31646 D.

Production

Some Observations in Butte, Mont. W. R. Ingalls. Considers that these copper mines will maintain their present production for 20 years, and that the cost will be reduced to 9c. per pound. 1800

w. Eng & Min Jour—March 16, 1912. No. 31205.

Smelting

Recent Improvements and Additions to the Smelting Plant of the Canadian Copper Co. David H. Browne. An account of the change from acid converters to basic converters. 2500 w. Qr Bul Can Min Inst, No. 18—Feb., 1912. No. 31440 N.

GOLD AND SILVER

Alaska

Gold Deposits of the Sitka, Alaska, District. Adolph Knopf. Abstract from Bull. 504, U. S. Geol. Surv. Describes the geology of the region, structural features of the orebodies, the mining properties, etc. 4000 w. Min & Sci Pr—March 2, 1912. No. 31063.

The Valdez Gold-Mining District, Alaska. L. W. Storm. Illustrated description of this district and its development. 3300 w. Min & Engng Wld—March 23, 1912. No. 31503.

Assaying

Method for Assaying Zinc-Box Precipitate. Harai R. Layng. From *Trans. of Am. Met. Soc.* Describes the method used. 1800 w. Min & Engng Wld—March 23, 1912. No. 31504.

California

Gold-Production in California. Charles G. Yale. Information concerning past production and the present condition of the gold-mining industry in the state. 1600 w. Bul Am Inst of Min Engrs—March, 1912. No. 31586 F.

See also Dredging, under *Gold and Silver*.

Cobalt

Recent Underground Development Work at Cobalt. Cyril W. Knight. A brief summary of certain recent underground developments, with maps. 2000 w. Qr Bul Can Min Inst, No. 18—Feb., 1912. No. 31439 N.

Cupellation

Cupellation of Gold Precipitate. Cecil J. Brooks. A short description of the process in use at Bau, Borneo, preparatory to refining the bullion by cupellation. Drawings. 2200 w. Min Mag—March, 1912. No. 31641 B.

Cyaniding

Cyaniding Weathered Pyritic Tailing. Herbert R. Edmands. Describes methods by which an extraction of 88 per cent were obtained. 2500 w. Eng & Min Jour—March 23, 1912. No. 31477.

Cyaniding Tailings in Colombia. Ralph W. Perry. Illustrated description of methods and costs of construction, and operation of three small temporary plants. 2000 w. Eng & Min Jour—March 9, 1912. No. 31105.

Dredging

Methods of Restoring Soil on Dredged Areas and Costs of Gold Dredging in Australia. Gives the stipulations of the Australia mining laws, and describes

plants for resoiling dredged land. 1800 w. Engng & Con—March 13, 1912. No. 31177.

Northern California Gold Dredging. Lewis H. Eddy. Describes different types of dredges used, each designed for the particular conditions. Map. 4000 w. Eng & Min Jour—March 23, 1912. No. 31478.

Present-Day Problems in California Gold-Dredging. Charles Janin. A review of the development and of the work of modern dredges. Ills. 5000 w. Bul Am Inst of Min Engrs—March, 1912. No. 31585 F.

Occurrence

An Association of Native Gold with Sillimanite. Thomas Leonard Watson. A microscopic study of the relations of the gold to the silicate minerals. Ills. 900 w. Am Jour of Sci—March, 1912. No. 31559 D.

Recovery

Treating Zinc Crusts and Drosses. William Poole. Abstracted from a paper read before the Sydney Univ. Engng. Soc. Considers the treatment of gold and silver crusts, cupellation, retort dross parting, etc. Ills. 3800 w. Mines & Min—March, 1912. No. 30975 C.

Separation

A Modification of the "Gay-Lussac" Method for Silver-Bullion Containing Tin. Luis Emlynn Salas. Reports experiments made to find the conditions whereby by the Gay-Lussac method might be applied directly to their bullions. 3000 w. Bul Am Inst of Min Engrs—March, 1912. No. 31587 F.

Silver Deposits

Genesis of Silver Deposits. W. G. Matteson. Comparison of geological features and conclusions in regard to the origin of various American deposits. 3500 w. Mines & Min—March, 1912. No. 30976 C.

IRON AND STEEL

Austria

The Styrian Erzberg (Der steirische Erzberg). A description of this iron mountain and the mining methods employed there. Ills. and Plates. 2100 w. Stahl u Eisen—Feb. 22, 1912. No. 31320 D.

Blast-Furnace Practice

The Rational Valuation and Quality Efficiency of Furnace-stock. John Jermain Porter. Deals with the smelting value and describes methods. 3300 w. Bul Am Inst of Min Engrs—March, 1912. No. 31588 F.

Calculations on the Fuel Requirements in Direct Blast-Furnace Reduction (Ueber die Berechnung des zur direkten Reduktion im Hochofen verbrauchten Kohlenstoffs). F. Wüst. Methods for this determination are described. 1750 w. Stahl u Eisen—March 7, 1912. No. 31339 D.

Blast-Furnace Slag

The Utility of Blast-Furnace Slag (Ueber die Verwertung der Hochofenschlacken). Hans Fleissner. Describes modes of treatment for its conversion into Portland cement. Ills. 4500 w. Stahl u Eisen—Feb. 8, 1912. No. 31318 D.

Ingots

The Use of Anti-Piping Thermit in Steel Ingots. C. Canaris. Gives results of a series of experiments on treated and untreated ingots to ascertain the effects of thermit on steel. 1500 w. Ir Trd Rev—March 28, 1912. No. 31612.

The Use of Anti-Piping-Thermit in Cast Iron Ingots (Ueber die Verwendung von Lunckerthermit bei Flusseisen-Blöcken). C. Canaris. Describes the method of applying thermit and gives results of tests. Discussion. Ills. 5800 w. Stahl u Eisen. Feb. 22, 1912. No. 31321 D.

Iron Ore

The Evolution of Iron and Steel Processes and the World's Reserves of Iron Ore. M. P. Angles d'Auriac. Extracts from *Bul. of the Soc. de l'Indus. Min.* Gives information concerning United States, Germany and Great Britain. Diagrams. 3000 w. Ir & Coal Trds Rev—March 1, 1912. No. 31157 A.

Italy

Italy's Iron Industry (Italiens Eisen-industrie). Review of metallurgic conditions in Italy. Ills. and Maps. Serial. 1st Part. 2800 w. Stahl u Eisen—Feb. 15, 1912. No. 31319 D.

Limonite

See Prospecting, under *Mining*.

Metallization

The Metallization of Low-Grade Iron Ores. George E. Edwards. Abstract of paper by Prof. Albert E. White to be published in *Mineral Resources of Michigan*. Discusses the interesting experiment in progress by J. T. Jones, by which low-grade ore is to be reduced to a product fit for blast-furnace use, and possibly for open hearth use in future work. 2500 w. Min & Engng Wld—March 9, 1912. No. 31093.

Metallurgy

The Beginnings of Physical Chemistry. Harry C. Jones. First of a series of articles of interest to metallurgists. 5000 w. Eng & Min Jour—March 23, 1912. No. 31475.

The Progress in Metallurgy (Les Progrès de la Métallurgie). Sir R. A. Hadfield. Brief review of metallurgical progress since the time of Faraday. Diagrams. 4000 w. Génie Civil—Feb. 17, 1912. No. 31407 D.

The Formation of Osmondite in Hypo-Eutectic Steel (La Formation de l'Osmondite dans les Aciers Hypo-Eutectiques). J. Calian. Metallurgic studies of its occurrence in steel of low fusing

points. Plates. 3500 w. Rev de Metal-lurgie—March, 1912. No. 31404 H.

Norway

Mining and Concentrating the Sydvaranger Iron Ores. Dwight E. Woodbridge. Describes methods used in Norwegian Lapland of electrical and mechanical interest. Ills. 4000 w. Engineering Magazine—April, 1912. No. 31547 B.

The Sydvaranger Iron Mines in Norway. Brief illustrated description of mines in the most northern province in Norway, and their fine equipment. 2500 w. Elec Rev, Lond—March 1, 1912. No. 31133 A.

Ore Deposits

The Effects of a Basic Igneous Intrusion on a Lake Superior Iron-Bearing Formation. Carl Zapffe. Report of investigation made to determine whether the alteration was a recrystallization, or whether the hot igneous mass was the cause of removal or introduction of constituents. 9500 w. Ec-Geol—Feb.-March, 1912. No. 31644 D.

A Peculiar Hematite Ore on the Tract of the Durham Mine, Durham, Penna. W. S. Bayley. Read before the Geol. Soc. of Am. Describes the occurrence. 1800 w. Ec-Geol—Feb.-March, 1912. No. 31645 D.

Rolling Mills

The Work Done and the Power Required in Rolling Steel. Harold Wheatley. Considers factors affecting the design and operation of driving machinery and how these factors are determined. 4500 w. Engineering Magazine—April, 1912. No. 31549 B.

Power Consumption of Mills for Rolling Girders, Wire and Plates. J. Puppe. From *Stahl und Eisen*. Information from a series of tests made to determine the most economical source of motive power for the work, resulting in the electrification of the mills. 1500 w. Ir & Coal Trds Rev—March 15, 1912. Serial. 1st part. No. 31545 A.

Electric Rolling Mills at Middlesbrough. Illustrated description of electrically driven reversible rolling mills showing modern practice. 3000 w. Engr, Lond—March 15, 1912. No. 31533 A.

Steel Works

A Self-Contained Steel Plant in Southern Ohio. Illustrates and describes additions and extensions of the Portsmouth Steel Co.'s works, making it independently operating. Plate. 3000 w. Ir Trd Rev—March 28, 1912. No. 31611.

Plant of the Portsmouth (O.) Steel Company. Illustrated description of the arrangement and equipment of plate mill, bar mill, and jobbing and sheet mills. 1800 w. Ir Age—March 28, 1912. No. 31594 C.

Sulphides

Oxidation of Sulphides. V. H. Gottschalk and H. A. Buehler. Second paper on an experimental study of the oxidation of natural minerals. 4500 w. Ec-Geol—Jan., 1912. No. 31191 D.

The Mineral Sulphides of Iron. E. T. Allen, J. L. Crenshaw, and John Johnston; with Crystallographic Study, by Esper S. Larsen. A study of the application of chemistry to the problems of ore deposition with study of crystals. Ills. 16000 w. Am Jour of Sci—March, 1912. No. 31557 D.

MINING

Accidents

Mines Accidents (Rescue and Aid) Act. Gives text of proposed new rules. 1500 w. Col Guard—March 1, 1912. No. 31143 A.

Costs

Costs and Cost-Conditions at Bluebell Mine, British Columbia. S. S. Fowler. A statement of costs and conditions concerning the mining and concentration of ore at the Bluebell mine. 1800 w. Qr Bul Can Min Inst, No. 18—Feb., 1912. No. 31436 N.

Drainage

The Loss of Mineral Areas in South Staffordshire. Isaac Meachem. Read before the S. Staffordshire and Warwickshire Inst. of Min. Engrs. Discusses large areas left unworked owing to submergence and to supports left for the surface. 2500 w. Ir & Coal Trds Rev—Feb. 23, 1912. No. 31051 A.

Electric Power

The Installation and Use of Electricity in Mines. Gives text of the new amended Special Rules relating to the installation and use of electricity in mines. 2500 w. Col Guard—March 1, 1912. No. 31144 A.

Electrification of the Penn Mines, Menominee Range. George E. Edwards. Illustrates and describes the system used in applying electricity to these Michigan iron mines, and some results. 2500 w. Min & Engng Wld—March 16, 1912. No. 31229.

Electric Power in Eastern Iron Ore Mines. John Liston. A discussion of the substitution of electric for steam power in the operation of mining properties at Mineville, N. Y. Ills. 4000 w. Ir Trd Rev—March 21, 1912. No. 31452.

Hydro-Electric Power for Minnesota Ranges. C. A. Tupper. Illustrated account of the Great Northern Power Co.'s project near Duluth, and the extensive transmission system. 3500 w. Min & Engng Wld—March 23, 1912. No. 31501.

Electricity Applied to the Scottish Shale Oil Industry. Jas. R. Laird. Read before the Assn. of Min. Elec. Engrs (W. Scotland Branch). Illustrates and describes the process and the electrifying

of the oil works. 2000 w. Ir & Coal Trds Rev—March 15, 1912. No. 31544 A.

Lancashire Electric Power Company's System, and Its Application to Lancashire Collieries. Charles D. Taite. Read before the Manchester (Eng.) Geol. and Min. Soc. Plans and detailed description. 3000 w. Ir & Coal Trds Rev—March 15, 1912. No. 31543 A.

Fuses

Investigations of Fuse and Miners' Squibs. Clarence Hall and Spencer P. Howell. The tests reported aim to show the relative safety and efficiency of different devices for igniting explosives. 5000 w. U S Bureau of Mines—Paper 7. No. 31290 N.

Haulage

Electric Haulages in Mines. W. C. Mountain. Read before the N. of Eng. Branch of the Assn. of Min. Elec. Engrs. Illustrated explanation of the types used underground in collieries. 4500 w. Ir & Coal Trds Rev—March 1, 1912. No. 31159 A.

Hoisting

Electrical Control of a Large Mine Hoist. H. W. Cheney. Describes the general layout of a mine, an electrically driven mine hoist and a novel control system, with tests. Ills. 4500 w. Pro Am Inst of Elec Engrs—March, 1912. No. 31579 F.

Electric Hoisting in South African Gold Mines. A. W. Brown. Illustrated description of the equipment and its operation. 1800 w. Elec Jour—March, 1912. No. 31603.

Electric Mine Hoists and Their Control. C. A. Tupper. Examines the claims of advocates of electric power, describing methods of hoisting and types of hoists. 2500 w. Min & Engng Wld—March 30, 1912. Serial. 1st part. No. 31687.

Hoisting Engines

Automatic Speed Regulation on Steam Hoisting Engines (Selbststättige Geschwindigkeitsregelung an Dampffördermaschinen). Herr Schönfeld. Describes new device operating on the drum. Ills. 2000 w. Glückauf—Feb. 24, 1912. No. 31336 D.

See also Winding, under *Mining*.

Hoisting Ropes

Results of Prussian Statistics on Mine Hoisting Cables for 1910 (Ergebnisse der preussischen Statistiken der Schachtförderseile für das Jahr 1910). Fr. Herbst. Report on mine cables tending to show the longevity of cables of varying sizes for the work produced. Ills. Serial. 1st part. 6800 w. Glückauf—March 2, 1912. No. 31343 D.

Labor

The Iron-Ore Miner of Northern Michigan. W. J. Lauck. An account of the racial displacements, the present workers and their economic status, etc.

2500 w. Min & Engng Wld—March 9, 1912. No. 31094.

Laws

A Discussion of Mining Law. H. V. Winchell. Read before the Can. Min. Inst. Considers features of mining laws in general and of the United States in particular. 6500 w. Eng & Min Jour—March 9, 1912. No. 31104.

1911 Bituminous Mining Law of Pennsylvania. An analysis of the portions of the law which will increase the cost of mining. 3300 w. Mines & Min—April, 1912. No. 31740 C.

Extent of Mining Titles Under the Mexican Law. D. A. Richardson. An explanation of the Mexican law affecting mining titles. 3500 w. Min & Engng Wld—March 30, 1912. No. 31690.

Machinery

Ore and Coal-Mining Machinery. C. A. Tupper. Considers its similarity and what each branch of the industry owes the other for its development. 2200 w. Mines & Min—March, 1912. No. 30963 C.

Management

Scientific Coal Mine Management. By Sim, and W. H. Reynolds. Describes three devices by the use of which knowledge of working conditions can be had daily. 2000 w. Mines & Min—March, 1912. No. 30965 C.

Mine Maps

Electrical Symbols for Mine Maps. H. H. Clark. Abstract of a paper read before the Coal Min. Inst. of America. Gives suggested symbols showing the methods of application and interpretation. 2000 w. Mines & Min—March, 1912. No. 30969 C.

Mine Workings

Some Observations on Ancient Mine Workings in the Transvaal. T. G. Trevor. Information from observation, with descriptions of workings. Ills. 7000 w. Jour Chem, Met, and Min Soc of S Africa—Jan., 1912. No. 31271 E.

Ore Deposits

The Original Source of Metalliferous Ores. G. W. Miller. Presents the hypothesis considered most reasonable in accounting for ore genesis by geologic structure. 2200 w. Min & Engng Wld—March 2, 1912. No. 30992.

Magmatic Origin of Ore-Forming Solutions. C. F. Tolman. A critical review of an article by A. C. Lawson, containing an attack on the theory of magmatic waters as important factors in ore genesis. 5500 w. Min of Sci Pr—March 16, 1912. No. 31450.

Placers

Dry-Placer Mining Methods. Wilbur Greeley Burroughs. Describes different kinds of separating apparatus used, and the geology by the dry-placer deposits. Ills. 3000 w. Mines & Min—March, 1912. No. 30973 C.

Plants

Coal Developments at Stearns, Ky. J. E. Butler. Illustrated description of the equipment and surface arrangements, and the use of an aerial tramway to transport coal across the river. 1800 w. Mines & Min—March, 1912. No. 30971 C.

The Chapin Mine of the Oliver Iron Mining Co. George E. Edwards. Illustrated description of the plant and methods used at a mine noted for its excellent management. 1200 w. Min & Engng Wld—March 2, 1912. No. 30989.

Prospecting

Limonite Prospecting and Mining. Charlton Dixon. Deals with brown hematite prospecting and open-cut mining with steam shovels. Ills. 2200 w. Mines & Min—March, 1912. No. 30972 C.

Rescue Apparatus

Experiments with the 1910 Pneumatogen (Versuche mit dem Pneumatogen 1910). Herr Grahn. Description of the 1910 model of this breathing apparatus for mine rescue work in gaseous mines. Ills. 3500 w. Glückauf—March 2, 1912. No. 31344 D.

Steam-Shovel Mining

See Prospecting, under *Mining*.

Supplies

Packing Supplies in a Mining Region. James Davis. Illustrations and suggestions for packing supplies for transportation to inaccessible regions. 2000 w. Min & Sci Pr—March 23, 1912. No. 31614.

Timbering

See Mine Timbering, under *Coal and Coke*.

Tipples

Tipple at Delagua Mine, Colorado. A. J. Reef. Illustrates and describes novel haulage and other features of new tipple. 2200 w. Mines & Min—March, 1912. No. 30964 C.

Valuation

The Valuation of Mineral Properties. T. A. O'Donahue. From a paper before the S. Staffordshire and Warwickshire Inst. of Min. Engrs. Considers points of principle on which differences of opinion exist with a view to establishing uniform methods. 2500 w. Col Guard—Feb. 23, 1912. Serial. 1st part. No. 31032 A.

Winding

Trials with Electric and Steam Winding Engines. From *Glückauf*. Report of committee appointed by three German associations for comparative determinations. 700 w. Col Guard—March 1, 1912. Serial. 1st part. No. 31142 A.

The Koepe Pulley Winder. Diagram and description of this endless rope system, discussing and comparing the endless-rope and double-rope systems. 2000 w. Ir & Coal Trds Rev—March 1, 1912. No. 31158 A.

MINOR MINERALS**Asbestos**

Serpentine Asbestos Deposits in the Berezowa, Kamenskaja and Manetnaja Estates, Ural, Russia. W. F. Kryshauofsky. (Abstract.) Brief description of the deposits, history, mining, treatment, and peculiar working conditions. 800 w. Qr Bul Can Min Inst, No. 18—Feb., 1912. No. 31437 N.

See also Wood Substitutes, under **CIVIL ENGINEERING**, *Materials of Construction*.

Asphalt

What Is Asphalt? Cecil Nathan. Explains the relative merits of the four materials known as asphalt. 2000 w. Surveyor—March 8, 1912. No. 31253 A.

Cement Mill

A Municipal Cement Mill. Burt A. Heinly. Brief illustrated description of a plant owned and operated by the city of Los Angeles, Cal., for furnishing cement for the city's aqueduct. 1500 w. Munic Jour & Engr—March, 1912. No. 31613.

Electric Operation of German Cement Factories. Illustrated description of an electrically operated cement mill near Obercaßell. 1500 w. Cement Age—March, 1912. No. 31459.

Gypsum

See Ore Deposits under *Copper*.

Magnesite

Magnesite and Its Technical Uses (Der Magnesit und seine technische Verwertung). Dr. Kern. A study of the properties and industrial applications of magnesite. 3200 w. Glückauf—Feb. 17, 1912. No. 31334 D.

Mercury

Quicksilver Mining in Tuscany (Der Quecksilberbergbau in Toskana). H. E. Müller. Studies of the geologic formation of the region, and modes of mining. Maps and Ills. 3500 w. Glückauf—Feb. 10, 1912. No. 31332 D.

Natural Gas

Liquefied Products from Natural Gas: Their Properties and Uses. Irving C. Allen and George A. Burrell. Considers gas liquefaction by pressure, crude, natural gas, characteristics of liquified natural gas, its uses, etc. 4000 w. U S Bureau of Mines—Paper 10. No. 31292 N.

Oil Fields

Developments in the Illinois Oil Fields. H. A. Wheeler. An account of development work and costs. 3000 w. Jour Assn of Engng Socs—Feb., 1912. No. 31194 C.

Phosphate

Phosphate Deposits and Mining Methods in U. S. S. R. Stone. Information concerning deposits in various localities. 1500 w. Min & Engng Wld—March 2, 1912. No. 30991.

Equipment of a Modern Phosphate Plant in Florida. C. A. Tupper. Illus-

trates and describes one of the best of the modern plants. 1000 w. *Min & Engng Wld*—March 9, 1912. No. 31092.

Potash

The Estimation of Potassium as Perchlorate. Gordon Surr. Points out the fundamental principles of the perchlorate process. 2000 w. *Min & Engng Wld*—March 16, 1912. No. 31231.

Salt

The Form of Salt Deposits. F. F. Hahn. Describes the occurrences of rock salt in the different countries, with explanations of the peculiarities. 4500 w. *Ec-Geol*—Feb.-March, 1912. No. 31643 D.

The Kayser Process for the Production of Table Salt and the Concentration or Evaporation of other Solutions (*Das Verfahren von Kayser zur Erzeugung von Kochsalz und Einengung oder Verdampfung sonstiger Lösungen*). J. Schrempf. Description of a mechanical device for the evaporation of liquids. Ills. 3000 w. *Glückauf*—Feb. 3, 1912. No. 31330 D.

Germany's Salt Production in the Years 1906 to 1910 (*Salzerzeugung in den Jahren 1906 bis 1910*). Statistical review. Diagrams. In two parts. Part I. 2000 w. *Oest Zeitschr f Berg- u Hüttenwesen*—Feb. 3, 1912. No. 31325 D.

The Salt Pits in Galicia and Bukowina (*Die Salinen in Galizien und in der Bukowina*). Felix Piestrak. Description of the geology of this immense salt deposit, and the history of its operation from the year 1044. Serial. 1st part. 5200 w. *Oest Zeitschr f Berg- u Hüttenwesen*—Feb. 17, 1912. No. 31327 D.

Tin

Tin Mining in Bolivia. O. Gore Adams. Describes the mines and methods, and gives information of interest concerning this region. 3500 w. *Aust Min Stand*—Feb. 8, 1912. Serial. 1st part. No. 31129 B.

ORE DRESSING AND CONCENTRATION

Chilean Mill

Slow-Speed Mill in Mexican Mining Practice. J. B. Empson. Abstracts of a paper read before the Mex. Inst. of Min. & Met. Discusses the Chilean mill in Mexico. Ills. 3000 w. *Min & Engng Wld*—March 23, 1912. No. 31502.

Classifiers

See Ore-Graders, under *Ore Dressing and Concentration*.

Mill Design

Progress in Mill Design. Frank E. Shepard. A review of milling practice with special reference to the design and performance of the milling equipment. 6500 w. *Eng & Min Jour*—March 16, 1912. No. 31204.

Milling Methods

Milling the Tam O'Shanter Ore. James M. McClare. An illustrated article describing the milling methods at this

Colorado lead-zinc-silver mine. 2200 w. *Mines & Min*—March, 1912. No. 30974 C.

Ore-Grading

A New Form of Ore-Grader. From *L'Echo des Mines et de la Met.* States the objects to be fulfilled in the mechanical treatment of ores, and describes the machine and its advantages. 1200 w. *Min Jour*—March 2, 1912. No. 31137 A.

Preliminary Handling of Ore at El Tigre. J. W. Malcolmsen and L. R. Budrow. Illustrated description of the plan adopted. The peculiar feature of the plant is the superimposed belts for sorting. 1000 w. *Min & Sci Pr*—March 16, 1912. No. 31449.

Roasting

The Practice in Blende Roasting. E. Schütz. Abstract translation from *Metallurgie*. Historical review of the development of methods, with description of some furnaces employed in Europe and America. Ills. 3300 w. *Eng & Min Jour*—March 16, 1912. No. 31206.

Separators

Dorr Thickeners as Aids in Isolating Rich Solutions. J. Leslie Mennell. Abstract of a paper read before the Mex. Inst. of Mines and Met. Gives a flow sheet and the methods of treatment, explaining the advantages claimed. 2200 w. *Min & Engng Wld*—March 16, 1912. No. 31232.

Tonnage

The Estimation of Tonnage. A. W. Allen. Considers existing systems used for the daily estimation of battery tonnage. 2000 w. *Min & Sci Pr*—Feb. 24, 1912. No. 30944.

MISCELLANY

Bolivia

Mineral Resources of Bolivia. Carlos Sanjines. A sketch of the mineral resources that are at present attracting the attention of mining people of the United States. Ills. 2200 w. *Min & Sci Pr*—March 9, 1912. No. 31174.

China

The Mineral Production and Resources of China. Thomas T. Read. Information concerning conditions in China, the mineral wealth and its present development, methods, production and related subjects. Maps and Ills. 13500 w. *Bul Am Inst of Min Engrs*—March, 1912. No. 31589 F.

Geology

Some Relations between Gravity Anomalies and the Geologic Formation in the United States. William Bowie. Gives results of a study made by the U. S. Coast and Geodetic Survey. 1200 w. *Am Jour of Sci*—March, 1912. No. 31558 D.

Relations of the Degree of Metamorphism to Geological Structure and to Acid Igneous Intrusion in the Narragansett Basin, Rhode Island. F. H. Lahee. Map and study of the geology of these

carboniferous rocks; their petrology and metamorphism; and the post-carboniferous intrusives. 3500 w. *Am Jour of Sci*—March, 1912. Serial. 1st part. No. 31560 D.

German Colonies

Mining in the German Colonies in the Years 1910-11 (*Der Bergbau in den deutschen Schutzgebieten in Jahre 1910-11*). Abstracts from official reports on industries in the colonies of Africa and the South Sea. 1500 w. *Glückauf*—Feb. 24, 1912. No. 31337 D.

Joplin

Mining and Milling in the Joplin District. J. J. McLellan. Illustrated description of methods used in this region. 2000 w. *Can Min Jour*—March 1, 1912. No. 31083.

Junk Smelting

The Treatment of Metallic Junk. Donald M. Liddell. A general review of the junk smelting industry. Ills. 3000 w. *Eng & Min Jour*—March 2, 1912. No. 30977.

Nova Scotia

The Domes of Nova Scotia. T. A. Rickard. Description of this gold-mining region, its geology, ore deposits, crenulated veins, and features of interest. Many illustrations. 23000 w. *Inst of Min & Met*, Bul 90—March 14, 1912. No. 31609 N.

Snowslides

Snowslides in Mining Districts of British Columbia. Arthur Lakes, Sr. Illustrates and describes snowsliding phenomena, and offers suggestions for avoiding them and lessening disasters. 2500 w. *Min & Engng Wld*—March 2, 1912. No. 30990.

Valuations

Notes on the Valuation of Ores and Minerals and on Metallurgical Calculations. George T. Holloway. Gives tables and notes for valuing ores and minerals, calculating recoveries from dressing and smelting operations, and other metallurgical work. 7000 w. *Inst of Min & Met*, Bul 90—March 14, 1912. No. 31608 N.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Signaling

The Indicative Arrangement and Location of Railway Signals. J. F. Gairns. Gives specimen locations indicating the main principles as applied on British railways. 2500 w. *Bul Int Ry Cong*—March, 1912. No. 31555 G.

Flashing Lights for Railway Signals. Illustrates and describes the Aga flashing-light signal system, in use on some of the Swedish lines. 600 w. *Ry Gaz*, Lond—March 8, 1912. No. 31250 A.

Report of the Block Signal and Train Control Board. Gives text of the fourth annual report. 9500 w. *Interstate Commerce Commission*—Dec. 26, 1911. No. 31285 N.

New Signals on the Pennsylvania. Describes proposed new work on the Pennsylvania. Also a sketch of what has been done by the signal department of the road during the past six years on their lines. 2500 w. *Ry Age Gaz*—March 8, 1912. No. 31101.

MOTIVE POWER AND EQUIPMENT

Air Brakes

The Regular Running of Goods Trains on Steep Gradients. A. Huberti and J. Doyen. Details of the proposed solution of the problem by the Westinghouse Co. Ills. 2400 w. *Bul Int Ry Cong*—March, 1912. No. 31554 G.

Collecting Moisture. Discusses methods of keeping moisture out of brake pipes. 1000 w. *Ry & Loc Engng*—March, 1912. No. 30950 C.

Releasing Brakes. Discusses methods and difficulties. 2000 w. *Ry & Loc Engng*—March, 1912. No. 30951 C.

Brakes

The New Mestre Hand-Brakes on the Chemins de Fer de l'Est (Nouveaux freins a main, système Mestre, des Chemins de Fer de l'Est). Describing this type of brake for ratchet or wheel use. Ills. 3000 w. *Génie Civil*—March 2, 1912. No. 31411 D.

Car Design

New Car for Memphis, Tenn. Illustrated description of a car having a steel underframe of novel form with malleable-iron post brackets. 800 w. *Elec Ry Gaz*—March 2, 1912. No. 31004.

Cars

Fish-Belly Center Girders for Cars. Arthur E. Heffelfinger. Gives a practical method for determining the length of the cover plate and the flange angles. Also a semi-graphic method for finding the deflection at any point along the beam. 2500 w. *Am Engr*—March, 1912. No. 31056 C.

Automobile Car for the Chicago, Milwaukee and St. Paul. Illustrates and describes special box cars for transporting automobiles. 600 w. *Ry Age Gaz*—March 15, 1912. No. 31208.

All-Steel Box Cars. Illustrated description of cars ordered for the Bessmer & Lake Erie. 1500 w. *Ry Age Gaz*—March 22, 1912. No. 31462.

Postal Cars for the Missouri Pacific Ry. Illustrated detailed description.

1200 w. Ry & Engng Rev—March 2, 1912. No. 31006.

Special Saloon for the Sudan Government Railways. Illustrated detailed description of a handsome car for official use. 1600 w. Ry Gaz, Lond—Feb. 23, 1912. No. 31023 A.

The Suburban Cars and Central-Caboose Baggage Cars of the Paris-Lyons-Mediterranean Company (Note sur les Voitures de Banlieue et les Wagons a Bagages a Guérite Intérieure Centrale de la Compagnie Paris-Lyon-Méditerranée). M. Lancron. Details of these cars. Ills. 2500 w. Rev Gen des Chemins de Fer—March, 1912. No. 31400 G.

Car Wheels

Control of Mixtures for Cast Iron Car Wheels. Asa W. Whitney. Discusses the advantages of the microscope in car wheel practice and some examples of cast iron chills. Ills. 2500 w. Ir Trd Rev—March 14, 1912. No. 31173.

Dynamometer Cars

Santa Fe Dynamometer Car. H. B. MacFarland. Illustrated detailed description of a high capacity car recently placed in service on the Santa Fe. 1000 w. Ry Age Gaz—March 29, 1912. No. 31636.

Locomotive Balancing

The Balancing of Locomotives. Jas. Dunlop. States the problem to be solved and then considers various types of construction and how the weights should and should not be dealt with. Ills. 3500 w. Mech Engr—Feb. 23, 1912. Serial. 1st part. No. 31026 A.

Locomotive Explosions

Locomotive Explosion at San Antonio, Texas. Illustrations and report of a disaster caused by the explosion of a So. Pacific locomotive. 800 w. Ry Age Gaz—April 5, 1912. No. 31806.

Locomotive Parts

Experiments on Fire-Boxes, Tubes, and Stays. Robert Weatherburn. A report of experiments and ordinary conditions of working. Ills. 3300 w. Engr, Lond—Feb. 23, 1912. Serial. 1st part. No. 31045 A.

Locomotive Performance

Locomotive Efficiency. Ernest Cordeal. Describes a system for comparing the performance of locomotives as to service, speed, load, and cost. 5000 w. Ry Mas Mech—March, 1912. No. 31221.

Locomotives

Maximum Interchangeability Designs of the Baldwin Locomotive Works. Illustrates and describes interesting designs worked out with careful attention to detailed interchangeability. 700 w. Ry & Engng Rev—March 2, 1912. No. 31007.

Balanced-Compound Locomotives. Illustrated description and discussion of features of a new engine designed for

heavy grades on the A., T. & S. F. Ry. 3000 w. Eng News—March 28, 1912. No. 31632.

New Superheater Goods Engines, Midland Railway. Illustrates and describes a new type of 6-wheel coupled goods locomotive, with superheater. 500 w. Ry Gaz, Lond—March 8, 1912. No. 31249 A.

Mikado Type of Locomotive for the Chesapeake and Ohio. Illustrated description of a 2-8-2 type. 1000 w. Ry & Loc Engng—March, 1912. No. 30952 C.

Mikado Locomotives of Great Power. Illustrated detailed description of 2-8-0 type ordered by the C. & O. Ry. 1000 w. Am Engr—March, 1912. No. 31060 C.

Experimental Mallet Locomotive for the Pennsylvania. Illustration with brief description. 300 w. Ry Age Gaz—March 1, 1912. No. 30959.

Mallet Locomotives for the Canadian Pacific Railway. Frederick H. Moody. Explains what the Mallet compound is, where it originated, the conditions in the United States and Canada that it is expected to meet, and describes the new Mallets for the C. P. Ry. Ills. 6000 w. Ap Sci—March, 1912. No. 31781 C.

New Superheater Tank Engines, North Staffordshire Railway. Illustrations, with brief description. 300 w. Engr, Lond—March 22, 1912. No. 31734 A.

Locomotive Number Fifty Thousand. Illustrated detailed description of an experimental Pacific type designed with all modern improvements to provide the maximum power per pound of weight. 2500 w. Sci Am Sup—April 6, 1912. No. 31770.

Pacific Type of Locomotive for the Chicago and Eastern Illinois. Illustration and description of engines using superheated steam. 1200 w. Ry & Loc Engng—April, 1912. No. 31746 C.

Pacific Type Locomotives. Illustrated description of locomotives of the 4-6-2 type for the N. C. & St. L. Ry. 700 w. Am Engr—March, 1912. No. 31062 C.

Pacific Type of Locomotive for the A., T. & S. F. Railway. Illustrations, with description of details. 800 w. Ry & Loc Engng—March 1912. No. 30948 C.

Locomotive Traction

Variations in Locomotive Tractive Effort with Speed. A. S. Williamson. Considers methods of estimating the variation and the accuracy of such estimates. 3000 w. Ry Age Gaz—March 22, 1912. No. 31464.

Motor Cars

Operation of Motor Cars in Cold Weather. C. G. Mahana. Suggestions and precautions. 1500 w. Ry Age Gaz—March 15, 1912. No. 31214.

Shop Practice

The Machinery of Railway Motors. C. B. Auel. Illustrates and describes details of the machinery operations.

2000 w. Am Mach—March 7, 1912. Serial. 1st part. No. 31069.

Steel Car Shop Kinks. Illustrates and describes special devices and methods. 1200 w. Am Engr—March, 1912. No. 31059 C.

Locomotive Machine Shop Kinks. R. E. Dette. Prize paper. Illustrated descriptions of devices and methods. 1000 w. Am Engr—March, 1912. No. 31061 C.

Shops

"Katy" Line Shops at Parsons, Kansas. F. A. Stanley. Illustrates and describes interesting machines, tools, and methods seen in these shops. 1200 w. Am Mach—March 7, 1912. No. 31071.

Train Lighting

Head End Electric Train Lighting. C. R. Gilman. Brief illustrated description of this system and its working, with general discussion. 8000 w. Pro W Ry Club—Jan. 16, 1912. No. 31296 C.

NEW PROJECTS

Finance

Preliminary Investigation of New Railway Projects. A. M. Van Auken. Aims to suggest a plan by which investors may form a fair judgment of the enterprise. 3300 w. Ry Age Gaz—March 8, 1912. No. 31103.

Florida East Coast Ry.

To Sea by Rail. M. B. Claussen. Illustrated account of the Key West extension of the Florida East Coast Ry. 2000 w. Cassier's Mag—March, 1912. No. 31190 C.

Grand Trunk Pacific

Construction Work on the Grand Trunk Pacific Ry. Detailed description of extensive work, with many illustrations and information of interest. 11500 w. Ry & Engng Rev—March 16, 1912. No. 31224.

M., S. & N. W.

Construction of the Milwaukee, Sparta & Northwestern. Map and illustrated description of this new line and the improvements in operation. 4000 w. Ry Age Gaz—March 1, 1912. No. 30961.

Oregon

The Construction of the Oregon Trunk and Des Chutes Railways in Central Oregon. An illustrated account of the building of these two competitive lines. 3500 w. Ry Age Gaz—March 22, 1912. No. 31463.

PERMANENT WAY AND BUILDINGS

Ballast

Notes on Contract Ballasting, Missouri Pacific Ry., Including Tables for Calculating Volume of Ballast Applied; Also Cost and Progress Recording Forms Used. D. W. Stradling. 6000 w. Engng & Con—March 20, 1912. No. 31456.

A Gravel Washing Plant for Railway Ballast; Structural Details and Methods and Cost of Operation. Illustrated description of a plant located 57 miles

from Richmond, Va. 1600 w. Engng & Con—March 27, 1912. No. 31616.

Construction

Construction of the Bingham & Garfield. Illustrated description of the construction of a 20-mile line in Utah, built mainly for ore transportation, but carrying on a general passenger and freight business. 1500 w. Ry Age Gaz—March 29, 1912. No. 31635.

Fire Protection

See same heading under CIVIL ENGINEERING, *Construction*.

Rails

An Analysis of Rail Failures from a Year's Statistics. Information from a report of the committee of the Am. Ry. Engng. Assn. from a study of rail failure statistics for the year ending Oct. 31, 1910. 2000 w. Eng Rec—March 23, 1912. No. 31480.

The Question of the Improvement of Rail Design and Specifications. W. C. Cushing. Presented at the Indiana R. R. Com.'s hearing on the rail question. Discusses requirements, properties, and manufacture. 5000 w. Ry Age Gaz—March 1, 1912. No. 30958.

The Problem of the Railway Rail. Robert G. Skerrett. Remarks on conditions found in the rail which caused the wreck on the Lehigh Valley R. R. in Aug., 1911, and discusses the question of sound steel. Ills. 1800 w. Sci Am Sup—March 2, 1912. No. 30929.

A New Specification for Steel Rails. Gives the report of the Committee of the Am. Ry. Engng. Assn. and the proposed specifications. 5000 w. Ir Age—March 28, 1912. No. 31596 C.

The Bond between Rail and Fish-Plate (Het een en ander over het verband tusschen het spoorstaafprofiel en de laschverbinding). E. C. W. van Dijk. Discussion on the unequal support between the rail profile and splice-bars. Ills. 5000 w. De Ingenieur—Feb. 24, 1912. No. 31382 D.

Roadway

Report of Committee on Roadway (1) Report on formulae for determining waterway areas; (2) unit pressures allowable on roadbeds of different materials; (3) tunnel construction and ventilation; (4) agricultural drainage as it affects railways. 3500 w. Bul Am Ry Engng Assn—Dec., 1911. No. 31283 N.

Station Lighting

Saving Effected by the Electric Lighting of Small Stations. Mr. Sussman. From *Zeit. des Ver. deut. Eisenbahnverwaltungen*. Considers principles to be observed in securing economy, 2500 w. Bul Int Ry Cong—March, 1912. No. 31556 G.

Stations

The New Main Depot in Leipzig (Der neue Hauptbahnhof in Leipzig). A.

Kleinlogel. Details of construction of this reinforced concrete station. Ills. Serial. 1st part. 1700 w. Beton u Eisen—Feb. 26, 1912. No. 31355 E.

Switches

Simplified Electric Interlocking Systems (Das vereinfachte elektrische Stellwerk). Herr Niemann. Description of electrically operated switching systems for terminals, etc., by means of which complicated systems are avoided. Ills. 6000 w. Zeitschr des Ver deutscher Ing—Feb. 17, 1912. No. 31360 D.

Terminals

The New York Central's Interest Free Terminal. Editorial on the plans to make the space above the terminal tracks pay the entire interest charges on the cost of building the terminal yards and station. 1000 w. Ry Age Gaz—March 15, 1912. No. 31207.

The New South Brooklyn Freight Terminal, New York Harbor. Charles W. Staniford and Philip Guise. Illustrated description, showing how some of the requirements of the harbor have been provided for. 7000 w. Eng News—March 7, 1912. No. 31078.

Ties

Report of Committee on Ties. Report on (1) size of cross-ties required for the stresses to which they are subjected; (2) tie renewals in continuous stretches versus single tie renewals; (3) metal composite and concrete ties. Ills. 17000 w. Bul Am Ry Engng Assn—Dec., 1911. No. 31281 N.

Recent Practice with Reinforced Concrete Ties (Neuere Erfahrungen mit Eisenbetonschwelle). Herr Bloss. Description of ties manufactured by Dyckerhoff & Widmann, and also the asbestos ties made by the firm of Rud. Wolle. Ills. 1600 w. Elek Kraft u Bahnen—Feb. 14, 1912. No. 31368 D.

Tracks

Report of Committee on Track. Report on (1) frogs, crossings and switches; (2) general specifications; (3) designs for turnouts. 3500 w. Bul Am Ry Engng Assn—Dec., 1911. No. 31282 N.

Location of Frog Points on Crandall's

Transition Curves. Anders Bull. Develops a formula for simplifying the location. 1200 w. Eng News—March 7, 1912. No. 31081.

Track Shims

Shims. E. R. Lewis. On the importance of good shims and good braces and their intelligent use in railway maintenance. Ills. 2500 w. Ry Age Gaz—March 15, 1912. No. 31215.

TRAFFIC

Freight Rates

Freight Rates on the Prussian Railway (Der Massengüterverkehr auf der Preussischen Staatsbahn). Heinr. Macco. Review of freight conditions. 3200 w. Stahl u Eisen—March 7, 1912. No. 31338 D.

Shortage

The Danger of Shortage of Railway Facilities. Abstract of a bulletin of the Railway Business Assn. States facts obtained by a recent inquiry into the railway situation. 3500 w. Ry Age Gaz—March 1, 1912. No. 30960.

MISCELLANY

British Railways

The Railway Situation. Editorial review of the past half year. 3000 w. Engng—Feb. 23, 1912. No. 31037 A.

Canada

A Short Sketch of the Development of Transportation Facilities in Canada. Collingwood Schreiber. A general review of the development of railways and waterways. 4000 w. Can Soc of Civ Engrs—Dec. 14, 1912. No. 31294 N.

Greece

The Railways of Greece. Percy F. Martin. Describes systems and criticizes features. 800 w. Ry Gaz, Lond—March 15, 1912. Serial. 1st part. No. 31522 A.

Railways in Greece. Discusses the opposition of the Turkish Government to the completion of European systems. 1200 w. Ry Gaz, Lond—March 1, 1912. No. 31138 A.

Investigations

Review of the Work of the American Railway Engineering Association. A summary of the year's investigations of the standing committees. 5000 w. Eng Rec—March 23, 1912. No. 31483.

STREET AND ELECTRIC RAILWAYS

Cars

New Center-Entrance Car in New York. Illustrates and describes a new design in which the car floor is only 10 inches above the head of the rail. Many novel features are introduced in these cars. Also editorial remark. 3500 w. Elec Ry Jour—March 16, 1912. No. 31228.

Electric Traction

Is Electric Traction Coming for Main-Line Railways? I. The Operation of Steam Railroads by Electric Motors. J. B. Whitehead. II. The Advantages of Steam Over Electricity on Railroads. Arthur Curran. Introduction, with discussion of both sides. Ills. 9000 w. Cassier's Mag—March, 1912. No. 31187 B.

Italy

The Electrification of the "Giori" Line (Note sur l'Électrification de la Ligne Giori). Pietro Verole. Description of the line from Genoa across the Apennines, partially by tunnel, connecting with Milan and Turin, profiles of the grades, and the electrical equipment. Ills., diagrams and maps. 10000 w. Rev Gen des Chemins de Fer—Feb., 1912. No. 31399 G.

The Naples "Metropolitan" (La Metropolitana di Napoli). Umberto Cassitto. General description of the Naples Metropolitan Electric Ry. Its present and proposed lines. Ills. and Plates. 3800 w. Ingegneria Ferroriararia—Feb. 15, 1912. No. 31423 E.

Locomotives

British Electric Locomotives for Canada. Illustration and brief description of one of three 50-ton electric locomotives for the British Columbia Elec. Ry. Co. 350 w. Ry Gaz, Lond—March 8, 1912. No. 31251 A.

A New Electric Locomotive Design. Illustrated description of a new type built for the N. Y., N. H. and H. R. R. 1200 w. Eng News—March 14, 1912. No. 31184.

The Single-Phase Locomotive with Continuous-Current Rectifiers. A. Soulier. Abstract translation from *L'Indus. Elec.* Describes a rotary rectifier, placed on a locomotive, for converting single-phase continuous-current. 1200 w. Elect'n, Lond—March 1, 1912. No. 31136 A.

Electric Locomotives Having the Anvert-Ferrand A. C. Rectifier (Locomotive électrique a redresseur-régulateur alternatif-continu de M. M. Auvert et Ferrand). A. Bidault des Chaumes. Description of this system as applied to electric locomotives. Ills. and Plate. 6000 w. Génie Civil—Feb. 17, 1912. No. 31406 D.

Motive Power

The Supply and Transmission of Power Self-Contained Road Vehicles and Locomotives. J. C. Macfarlane and H. Burge. Discusses battery-propelled vehicles, patrol-electric vehicles and oil engine electric system for suburban railways. 9000 w. Inst of Elec Engrs—Feb. 22, 1912. No. 31016 A.

Paris

Development of Transport in Paris. Editorial review of changes in passenger traffic. 4000 w. Engng—March 1, 1912. No. 31148 A.

Power Stations

See same heading, under ELECTRICAL ENGINEERING, *Generating Stations*.

Rail Corrugation

Report of the Commission on the Determination of Rail Corrugation (Rapport der Commissie van onderzoek betreffende de golfvormige afslijting der rails).

The amount of corrugation determined by pointers attached to the car wheels. Ills. 3000 w. De Ingenieur—Feb. 24, 1912. No. 31381 D.

Railless

The Trolley Vehicle System of Railless Traction. Henry C. Adams. Describes the various methods of applying this system, and improvements introduced in England. Ills. 10500 w. Soc of Engrs—March 4, 1912. No. 31280 N.

Shops

New Shops and Carhouses of the Boston Elevated Railway in Cambridge, Mass. Illustrated description of a large storage carhouse, shop and yard, and an operating carhouse. 1500 w. Elec Ry Jour—March 23, 1912. No. 31511.

Simplon

The Electric Traction of the Simplon (La Traction Électrique au Simplon). A statement of the electrical equipment for the Simplon tunnel. Ills. 5500 w. Alliance Industrielle—Feb., 1912. No. 31417 D.

Subways

Subway Equipment Improvements. Illustrated description of methods and devices which increased the capacity of the N. Y. system from 400,000 to 1,000,000 passengers per day. 6000 w. Eng News—Feb. 29, 1912. No. 30939.

Subterranean Railways in Rome (Strada ferrata sotterranea in Roma). G. Cadolini. Review of the construction plans of the Rome-Ostia line. 2400 w. Ann della Soc d Ing e d Arch Ital—Jan. 16, 1912. No. 31419 E.

Switzerland

The Bernina Railway. Alfred Gradenwitz. Illustrated description of this electric line and its equipment, passing through beautiful mountain scenery in Switzerland. 1800 w. Sci Am Sup—March 23, 1912. No. 31429.

The Bernina Railway (Die Bernina-bahn). E. Bosshard. General description of this electric railway and its construction, with details of its operation. Ills. and maps. Serial. 1st part. 3000 w. Schweiz Bauzeitung—Feb. 10, 1912. No. 31366 D.

New Electric Roads in Switzerland (Neue elektrische Bahnen der Schweiz). P. Poschenreider. Review of the more recently constructed electric railways. Ills. Serial. 1st part. 3200 w. Zeit d Oest Ing u Arch Ver—Feb. 16, 1912. No. 31365 D.

Transport

Transport Methods with Loaded Wagons and Wagon Parts (Das Beförderungswesen mit aufgeladenen Fahrzeugen und Fahrzeugteilen). H. R. v. Littrow. Illustrating methods of such transport by means of electric railways. Ills. Serial. 1st part. 3600 w. Zeit d Oest Ing u Arch Ver—Feb. 9, 1912. No. 31364 D.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m*. Brussels.
American Architects. *w*. New York.
American Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brickbuilder. *m*. Boston.
Builder. *w*. London.
Bull.-Bur. of Standards. *qr*. Washington.

Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. of Can. Min. Inst. *qr*. Montreal.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m*. Liège.
Bull. Tech. de la Suisse Romande. *s-m*. Lausanne.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Cassier's Magazine. *m*. New York and London.
Castings. *m*. Cleveland, O.
Cement. *m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Commercial Vehicle. *m*. New York.

- Compressed Air. *m.* New York.
 Consular Reports. *m.* Washington, D. C.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineer. *w.* London.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Elektrische Kraftbetriebe u. Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u. Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering-Contracting. *w.* New York.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Cold Storage. *m.* London.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Jour. N. E. Water Works Assn. *qr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *qr.* London.
 Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Metallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal and Engineer. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *qr.* Philadelphia.
 Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Public Works. *qr.* London.
 Quarry. *m.* London.
 Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Loc. Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Gén. des Chemins de Fer. *m.* Paris.
 Revue Gén. des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
 Signal Engineer. *m.* Chicago.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.



CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Assaying

The Elements of Assaying (Einführung in die Probierkunde). By C. Schiffner. Size, 8½ by 5½ in.; pp., 171. Ills. Price, \$1.50. Halle a. d. S.: Wilhelm Knapp.

An elementary textbook intended for the use of teachers in mining schools, technical highschools, etc. Detailing class-room experiments in the physics and chemistry of assay methods; the requisite apparatus; the reactions; and various methods in the assay of gold, silver, platinum, etc.

Building Material

Building Stones and Clays. By Edwin C. Eckel. Size, 9 by 6 in.; pp., 262. Ills. Price, \$3.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Discusses by chapters the origin and characteristics of igneous rocks in general, granites, traps and basic, serpentine and soapstone; sedimentary rocks in general, slates, sandstones, limestones, marbles; clays in general, residual, transported; and the distribution and field examination of both stones and clays.

Coals of Canada

An Investigation of the Coals of Canada with Reference to Their Economic Qualities: Conducted at McGill University, Montreal, under the authority of the Dominion Government. By J. B. Porter, E.M., D.Sc., and R. J. Durley, Ma.E., assisted by Théophile C. Denis, B.Sc., Edgar Stansfield, M.Sc., and a staff of special assistants. Under authority of the Government of Canada, Department of Mines, Mines Branch. Hon. W. Templeman, Minister; A. P. Low, LL.D., Deputy Minister; Eugene Haanel, Ph.D., Director. Size, 6½ by 10 in.; pp., 233. Plates. Ottawa: Government Printing Bureau.

Volume I, just issued, is a book of 233 pages, with many tables, inserted plates, diagrams and maps. Part I, introductory, by Dr. J. B. Porter, explains the inception of the work, the organization of the investigation, the coal fields examined, with a list of coals tested, and the divisions into which the study was separated, concluding with an outline of the substance of the report and an interpretation of the results. Part II, by T. C. Denis, covers more than 100 pages with

a detailed review of the coal fields of Canada, their geographical and topographical relations, history, and economic and statistical aspects. This is substantially a compilation from the reports of the Geological Survey, but was much needed because of frequent inquiries made of the Government for a summary of information, and was therefore, as it seems, rightly included in the main work. Parts III and IV cover a description of the samples and the methods of collection and sampling, (36 pages). Part V is devoted to "The Mechanical Purification of Coal, Commonly Called Coal Washing," (40 pages). Part VI is given to the manufacture and testing of coke, (33 pages). The table of contents covers also Volume II, Parts VII, VIII and IX, which will form a book of 184 pages, devoted to boiler tests, gas-producer tests, and the work of the chemical laboratory.

An important feature of the method followed is the introduction and interpretation of the work, and the method of proceeding from the general to the particular and specifically technical, thus greatly facilitating the study of the non-specialist, and broadening the value of the investigation. Thus, the 18 pages of introduction to Volume I as a whole are paralleled by an introduction to each of the seven divisions, the subject of the division being first dealt with in a general way, which is next followed by an extended description and discussion of the experimental work and concluded by a carefully tabulated summary of all tests.

Volumes III, IV, V and VI will be devoted almost entirely to tabular statements of results.

History

The History of the British Post Office. By J. C. Hemmeon. Size, 9 by 6 in.; pp., 261. Price, \$2.00. Cambridge: Harvard University.

A general résumé of the development of the British Post Office from its inception to the present time is presented in the first four chapters. The remaining twelve chapters are concerned with a more detailed description of the different activities which accompanied the development, including such subjects as Travelers' Post and Post Horses; Sailing Packets and Foreign Connections; Rates and

Finance; Monopolies and the Telegraph and Telephone Systems in connection with the Postal Department.

Measurement

Percentage Unit of Angular Measurement, with Logarithms. By John Coleman Ferguson. Size, 10 by 6½ in.; pp., 467. Ills. Price, \$20.00. New York and London: Longmans, Green & Co.

The method devised by the author is based on a decimal system of angular measurement, i. e., 45 degrees equal 100 per cent. On this basis he has evolved logarithmic tables and formulae for the substitution of percentage units for the customary degrees, minutes and seconds in trigonometric work.

Oil Fuel

Oil Fuel. Size, 8 by 5 in.; pp., 149. Ills. Price, \$1.00. New York and Houston: The Texas Company.

A well prepared handy volume stating some of the advantages obtained in the use of oil fuel, with specific data on the means of attaining the best results; formulae and tables for the use of steam engineers; comparative values of coal and oil as fuel, etc.

Refrigeration

Elementary Mechanical Refrigeration. By Fred. E. Matthews. Size, 9 by 6 in.; pp., 172. Ills. Price, \$2.00. New York and London: McGraw-Hill Book Company.

In nine chapters. The first and second chapters discuss the theory of refrigeration and its mechanical development, and the ninth the duty of refrigerators. The intervening chapters present the various systems in use, their installation and operation.

Scientific Management

Applied Methods of Scientific Management. By Frederick Parkhurst, M.E. Size, 6 by 9 in.; pp., 320. Plates. Price, \$2.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first eight chapters are an expansion of a series of articles which appeared in *Industrial Engineering* and described the actual methods and measures employed in establishing "Scientific Management" in the shops of the Ferracute Machine Co. at Bridgeton, N. J. The remaining 100-odd pages are an appendix giving the organization record of the same company. This consists of 39 sections, covering the duties of officers, departmental instructions, reports required, symbols, move orders, follow-up methods, time-keeping and tool-room systems, etc. It is a sort of diagrammatic representation of the results of the work described in the eight chapters preceding.

Mr. Parkhurst's demonstration of the practical working out of the Taylor system in a specific instance has attracted much interest. To many minds, perhaps

to most minds, even the underlying principles are best understood when they are reduced to concrete illustration. Mr. Parkhurst defines his work as being conducted "on lines parallel to those laid down by Mr. Taylor and particularly adapted to a business employing 100 people or more."

In a general way, the chapters cover consecutively (1) organization; (2) the sales department, counting-room, engineering-room and drafting-room; (3) planning department; (4) systematic routing; (5) the stores department; (6) standardization and development of the manufacturing system; (7) the work prerequisite to time studies; (8) a concrete example of progress from inquiry to shipment, and a comparison of results under the old and new methods. In this last section, 275 pieces are tabulated under old labor cost in hours and wages, and new labor cost in hours and wages. The average reduction of cost obtained is about 60 per cent in time, and more than 50 per cent in cost.

Turbines

Marine Steam Turbines. By Dr. G. Bauer, O. Lasche and M. G. S. Swallow. Size, 9 by 6 in.; pp., 214. Ills. Price, \$3.50. New York: The Norman W. Henley Publishing Co.

A supplementary volume to the work on the Design and Construction of Marine Engines and Boilers, dealing with the progress in the propulsion of naval vessels by the steam turbine.

The Steam Engine and Turbine. By Robert C. H. Heck. Size, 9 by 6 in.; pp., 631. Ills. Price, \$5.00. New York: D. Van Nostrand Company.

A textbook for engineering colleges, presupposing a general knowledge of the form and working of steam plants, but developing a rational theory from fundamental principles to the fully developed ideal steam engine.

Valuation

Essential Points Governing the Financial Value of an Engineering Property. By Schuyler R. Schaff. Size, 6½ by 4 in.; pp., 87. Price, \$1.00. New York: The Richardson Press.

An attempt to explain the influence of the engineer on the financial success of such projects as Water Supply, Railroads, Hydro-Electric Systems, Drainage, etc.

Water Powers

Water-Powers of Canada. By Leo G. Denis and Arthur V. White. Size, 9½ by 6½ in.; pp., 397. Ills. Ottawa: The Mortimer Co., Ltd.

Prepared under the auspices of the Canadian Commission of Conservation, giving a general practical outline of the sources of available water power in the several Canadian provinces. Several chapters have been contributed by other authorities.



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No. 3

SEA-BORNE TRAFFIC AND THE TITANIC DISASTER

By Richmond Pearson Hobson

Captain Hobson's article is of striking interest, both in its analytical and constructive interpretations of the foundering of the "Titanic." In the former he presents authoritative deductions of the mode and sequence of the accident, by which the probable extent of the injury is made much less than has been commonly conjectured, and structural defects are more heavily charged with the responsibility than in many opinions heretofore expressed by others. In the latter, or constructive function, he reduces his recommendations for greater safety at sea to concise form, in which they may be clearly considered by the authorities or tribunals who may pass upon the case or legislate in the cause of future protection against losses so frightful. Dr. Soper's thoughtful proposal for an international marine conference, page 434 of this number, may be read with much profit in further extension of this thought.—THE EDITORS.

IN the early ages of the race man was completely under the heel of nature. In his helplessness he endowed nature's over-powering phenomena with supernatural attributes. The ocean covers three-fourths of the earth's surface and its tributaries, bays, harbors, rivers, ramify the other one-fourth of land surface.

The specific gravity of man's body and of most of his commodities is greater than that of water, so the ocean and its tributaries have hedged man about, shutting off tribes, nations, races, and locking up continents.

From the earliest day man has applied himself tirelessly to the task of overcoming these barriers. He early sought the aid of buoyant objects,

then began constructing and operating vehicles.

STRUGGLE OF THE AGES

The log gave way to the dug-out, the dug-out to the built-up canoe, the canoe to the boat, the boat to the ship, first of wood, then of iron, then of steel. Muscular power was the first power of propulsion applied to the paddle, then the oar. Muscle gave way to the tireless winds and sails. Sail power gave way to steam.

As the conquest advanced, water transportation assumed an ever-increasing importance. The ocean supplied highways already constructed, offering no hills to climb against gravity, eliminating the friction of solids on solids involved in land transportation. History shows that the wealth and survival of nations has

been determined by the control of the sea, with its advantages for transportation of goods and expansion of a nation's power. Indeed, the control over water approaches, supplying protection without the greater centralization of armies, has enabled maritime nations to evolve liberal institutions.

In the long struggle with the ocean to secure these advantages, man in every generation has beheld his vehicle crushed, whether of wood or iron or steel, and has seen his power whether of muscle or wind or steam set at naught.

From this ancestral struggle man has inherited a mysterious dread of the sea that is semi-superstitious. Special hymns and prayers are offered up for "those in peril on the sea." In reality man's conquest of the sea is more complete by far than his conquest of the land. For decades traveling on sea has been the safest of occupations. Yet in the public mind the question of safety has maintained its old place of first consideration, a place of exaggerated importance at this stage. One of the real dangers of the present conditions of the public mind will be a tendency to hamper the steady progress of ocean transportation with unnecessary precautions for safety. This is only natural. All sea losses are naturally dramatic, but this disaster of the "Titanic" was the most dramatic disaster on record, whether of land or sea.

In no earthquake, volcano, tidal wave, in no flood, or fire, has nature ever struck man so squarely between the eyes. It is literally true that the world for days was stunned and even now has scarcely recovered its equilibrium.

In spite of the inspiration of the brave lives that show the spirit soaring above matter, the shock tended to

intimidate man before the cosmic power of nature. No fury compares to the fury of the ocean. Nothing is as pitiless as water. The prosperity and amity of nations, the future development of mankind, rest in large measure upon ocean transportation, and man must not relinquish one foot of his conquest. To interpret this great ocean disaster properly, to offset the shock and turn it to usefulness, we must look to the real conqueror of nature—the engineer. In this article I shall only endeavor to anticipate the ultimate findings for which the public will not, and legislators cannot, wait. The sketches and approximate calculations used were prepared in the Bureau of Construction and Repair, Navy Department, Washington, D. C., from general plans of the "Titanic" published in the *Ship Builder* (English) of June, 1911.

THE PROBLEM

The problem of safety at sea, like the problem of safety on land, is one of adjustment. There is no such thing as absolute safety in the world. The object of building and operating ships is to supply marketable transportation on a commercially profitable basis. It is conceivable that the matter of safety could be pushed to such extent that the increase in first cost and the decrease in efficiency of operation might wipe out all profits at present rates, or cause a serious increase of rates and increase in the cost of transportation.

As a matter of fact, year in and year out, general water transportation under existing conditions is comparatively safe. The Steamboat Inspection report for the year 1911 showed only 392 lives lost out of 314,768,885 passengers carried, including ferries. The United States Bureau of Navigation's reports for American shipping for 1911 show only 196 lives

lost with the loss of 315 vessels. The British reports show 680 lives lost in British shipping with the loss of 153 vessels. The list of injured in these cases is very small. Compare these figures with transportation on land. The street cars in single cities kill more than all the steamboats and ferries of the nation. The Interstate Commerce Commission's report for 1911 shows that the steam railroads of the United States last year killed 10,396 and injured 150,159, and the electric railroads killed 420 and injured 3,663.

Transportation by water is so much safer than transportation by land that the two cannot be put in the same class, and yet records of life-insurance companies and accident-insurance companies show that traveling by rail is far safer than not traveling at all, and companies give reduction in insurance rates to traveling men. The accident risk on a public conveyance on the average is only half the risk off such a conveyance.

Of the few lives that are lost on vessels, most of the number are lost in the coasting trade and along or near the shore. Very few are lost at sea. Generally speaking, a passenger on board ship at sea is safer by far than anywhere else in the world. Theoretically, safety is a primary factor in sea transportation, because without safety the losses become heavy, and the marketability of the transportation declines. In reality and in practice, safety is only a secondary matter. It would be an international calamity greater than the loss of a hundred "Titanics" if the development of ocean transportation and the evolution of ships in size, speed, efficiency, and cheapness were given a serious set back by a wild exaggeration in the public mind as to the dangers at sea. Investiga-

tion shows, however, that the dangers at sea can be reduced in many cases far below their present low level, by slight modifications in construction, equipment, and operation, without interfering with any primary factor of efficiency and at very little cost, far less than the cost lavished upon luxury, ornamentation and useless display.

THE DANGERS

The dangers at sea are of two kinds, dangers from within and dangers from without. The dangers from within are those from fire and from boiler explosions; and those from without are those of collision with ships, derelicts, and and ice.

DANGER OF FIRE

The danger from fire is more serious than is generally believed. It is much greater than the danger from collision, and is becoming more and more dangerous with the increased outlay upon luxury and display. The main structure of the ship and most of its essential parts are of metal, but many of the fittings, nearly every feature of ornament and every trapping of luxury, are highly inflammable. No one who has not been aboard the Spanish wrecks at Santiago can conceive how fire can sweep the inside of even a metal ship. Admiral Cervera described to me the experience on board the Teresa in these words: "The second shot that came on board set us on fire. The fire-main was damaged. Soon we were unable to cope with the fire. It swept through her from bow to stern. There was not a space as big as the palm of your hand where life could have been sustained. An insect could not have lived on board. We had to get overboard or be burned." It is true the Spaniards had not cut out their wood work and thrown overboard all unnecessary inflammables,

as we had in the American fleet, but the inflammability of one of their war ships was much less than that of a luxurious ocean liner. I foresee the time when fire will ravage one of the ships with more frightful loss of life than in the sinking of the "Titanic." The ship-builders and ship-owners of mercantile vessels should take a page out of the book of the efficient navies of the world, and reduce the inflammable materials used in construction, develop further the fire-main system, and multiply the practice and improve the discipline in fire drills.

DANGER OF BOILER EXPLOSION

The danger of boiler explosion on board ship is not as serious as the same danger ashore, in power houses, or in factories and office buildings. Due precautions, particularly in the efficiency of fire-room personnel, will reduce this danger to a minimum of only secondary importance, in most cases. But this cannot be said of the "Titanic." Reference to Figure 1 (a transverse section of the "Titanic") shows that her boilers were out close to the sides of the ship, with no inner skin to protect them. Reference to Figure 3 shows that the boiler spaces extend for over a third of the whole length of the ship and the bodies of the boilers themselves offer a target covering a considerable part of this space. A craft of comparatively small size, colliding perpendicularly or even obliquely in this space, would have easily reached a boiler. In collision, the "Titanic" ran about as much danger from being blown up by a boiler explosion as from sinking from the inflow of water. No boiler located in the wings should be left without the protection of a partial longitudinal bulkhead, or at least an inner skin on the side. This risk on the "Titanic," though not great, was unnecessary. At very little cost and

no difficulty, the inner skin could have been carried up the sides in the boiler spaces as far as the lower deck. In fact, it would have been good protection to take the same precaution in the engine-room space.

The question of dangers from without is essentially a question of collision. The danger of being overcome by stress of weather may be eliminated. With reasonable skill on the part of officers and crew, the average ocean liner out on the sea can weather without serious difficulty any storm ever brewed.

DANGER FROM COLLISION

The question of danger from collision divides itself into two parts, the danger of incurring collision and the danger of sinking from the effects of collision.

The year around, the danger of colliding with another ship is greater than the danger of colliding with derelicts, and this danger in turn, is greater than the danger of colliding with ice.

In a thousand passages across the sea, year in and year out, there will not average one collision from all these sources combined. Nevertheless, there are simple precautions that ought to be taken to eliminate this one chance in a thousand.

DERELICTS

For derelicts the various governments should co-operate more effectively in destroying those located, having vessels equipped especially for the purpose, employing not only explosion but oil and fire. All vessels should promptly report the sighting of a derelict wherever located, and the vessel detailed to destroy the derelict should stay with it until the destruction is complete, and during the while should with wireless keep the sea around notified of its presence.

ICE

For ice, the ocean lanes should be chosen during the ice season to reduce further the chances of meeting ice. During this season the lanes exposed should be patrolled by Government vessels, the Governments co-operating. Where an ice field or a berg is located by any vessel, prompt report should be made and all vessels notified. A Government vessel should be detailed for an important field or berg and stay with it till all danger is passed, keeping the sea around notified by wireless of its presence. The experiment might be made with explosives and with cheap shell fired by war ships to hasten the disintegration of the ice, and towing might be resorted to in certain cases to get the ice out of the way. When in or near ice, the speed at night should be reduced. The lack of this precaution doubtless cost the wreck of the "Titanic."

For avoiding vessels, the lanes of eastward courses and westward courses should be laid out by general consent well apart, and the lanes for regular north and south courses and other courses should be well defined and followed when practicable, and vessels approaching converging courses should send out special wireless notices and take special precautions.

Special wave lengths of wireless should be set apart for notifying other vessels of approach, and calls sent at intervals during the night and in fogs, each vessel picking up and keeping in touch with all others within reasonable distances.

Fog signals could be developed further, including communication through the water; search-light work could be applied to advantage with regularity at night; by general arrangement the speed in fog should be reduced and regulated according

to the obscurity. Speed should in all cases be reduced in proportion as the danger, known or suspected, increases. In proportion as the speed and size of vessels increases, manœuvering power should be developed as far as practicable, by increasing the power of the rudder and steering gear. In all cases the greatest factor of security lies in the personnel of the ship, their organization and discipline. The standard of officers, petty officers, and seamen should be kept high, their duties and responsibilities should be clearly defined and a high standard of performance required. The lookouts, including the wireless operators, should be required to be especially efficient. The deck officers and lookouts should be examined specially for hearing and for sight, vision and color-blindness. Lookouts should be supplied with night glasses when on duty at night. Officers should eliminate social relations with passengers and should mess to themselves. Officers and crew, as on all first-class railroads, should be forbidden to drink beverages containing alcohol.

Observing the simple precautions recommended above in a general way the "Titanic" would have escaped the collision. Let us now examine if any simple precautions would have kept her from sinking after the collision or reduced the loss of life when she sank.

REDUCING THE DAMAGE OF COLLISION

While the chances of collision are small in any case, and very small when proper simple precautions are taken, the chances of sinking after collision are much greater, and the chances of heavy loss of life in sinking are still greater.

How can a ship be prevented from sinking after suffering extensive damage below the water line?

A ship floats upon its reserve buoy-

ancy, its buoyancy available above the water line, and sinks when the weight of water admitted equals this reserve buoyancy, at which point no buoyancy is left above the water line.

To prevent sinking, therefore, after damage below the water line, the weight of water entering must be kept below this limit. Broadly speaking, the menace to the vessel's life will be proportional to the amount of water entering, and the degree of safety in collision is proportional to the limitations placed upon the space opened up to the sea. The only safe way to place such limitations is by water-tight sub-division. Nevertheless, there may be cases where the efficient use of a collision mat hauled over the breach on the outside could give control. Such mats should be provided for merchant vessels as on men-of-war, and the crew exercised in getting them over the side and bottom.

In rare cases the pumps can drain the water as fast as it comes in and repairs can be made on the inside. More frequently, when the water-tightness of internal sub-division is impaired under the pressure, the efficient use of the pumps can keep the water limited to the compartment breached or keep it under control. An efficient pumping system of large capacity, therefore, is a prime necessity and tests should be made frequently to see that it is in working order. Still, no pumping system can cope with the inrush of water through a large breach below water. So a vessel's safety in collision is practically determined by its water-tight sub-division. Minute sub-division can be realized by working an inner skin a short distance from the outer skin. This is very effective in the form of a double bottom in cases of grounding, and is equally effective on the sides in cases of glancing

blows like that received by the "Titanic." If an inner bottom and inner skin rising to the lower deck had been worked forward to bulkhead 2, or even to bulkhead number 3, the damage would probably have been very slight. The working of this second skin is not difficult and is not expensive, and the added security against long shallow wounds, so dangerous as they come aft from the bow, is very great. Every ocean liner should carry this inner skin, at least to the bulkhead forward of the forward boiler-room bulkhead, and preferably to the second bulkhead forward of it. In every case it should be worked up the sides in the boiler and engine-room spaces, unless there is a longitudinal wing bulkhead to protect these vast compartments from flooding. Reference to Figure 1 shows how the "Titanic's" builders omitted this skin and left both the boilers and these great compartments exposed. The cost would have been so small, and the added safety so great, that no excuse seems plausible for such an omission, though this feature may not have been involved in the actual sinking of the ship. Figure 2 shows a new ocean liner where a strong special longitudinal bulkhead is worked in in this space.

In the internal sub-division by water-tight decks and bulkheads, the general rule in vessels of this kind is to provide against a breach at a transverse bulkhead that, flooding the two compartments making the largest total, would leave the vessel safely afloat. Figure 3 shows the bulkhead arrangement of the "Titanic," with fifteen water-tight transverse bulkheads. The spacing of these bulkheads is well within the requirements of the rule, though many of the compartments flooded would admit more than four-thousand tons of water; but the construction of the

bulkheads does not insure the limiting of the water to the spaces breached. The vessel leaning toward the damage and settling deeper and deeper, the water will rise higher and higher unless it is limited by a water-tight deck. Therefore, there must be an effective water-tight deck above

above the water line, while the second bulkhead extends continuously only to the lower deck at the water line. The integrity of the lower deck and middle deck is undermined by hatches numbers 1 and 2. This whole part of the ship fails in both the deck and in the bulkhead requirements.

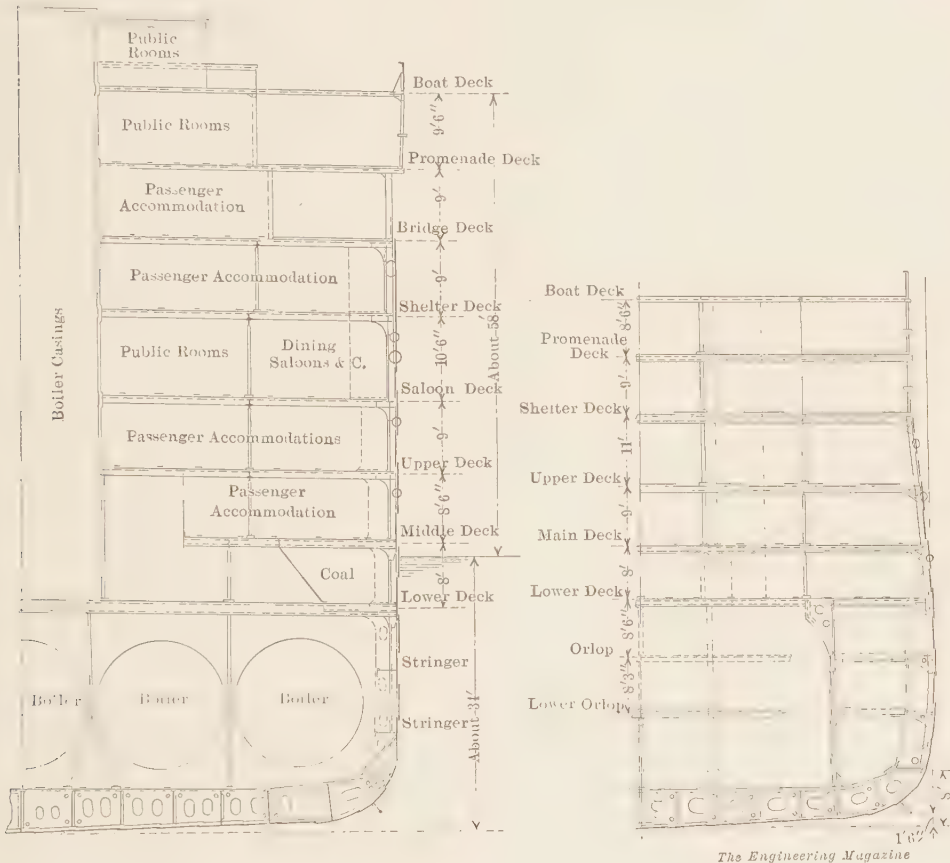


FIG. 1, 2. MIDSHIP SECTION OF THE "TITANIC," AND OF LARGE LINER WITH LONGITUDINAL BULKHEADS.

the damage, or the bulkheads must extend so high that the tops will not come under water when the vessel changes trim or heels. Safety of construction dictates both the use of the water-tight deck and the high bulkhead. Figure 3 shows an unsatisfactory construction on the "Titanic," particularly forward. Counting from forward, nine of the fifteen bulkheads extend only one full deck space

As though to make a bad condition worse, the firemen's tunnel or passage leads from forward of the second bulkhead aft as shown in Figure 4. This passage traverses bulkheads 3 and 4 leading to the forward fire-room, so that in case of damage to bulkheads numbers 1 and 2, water accumulating on the lower deck abaft the collision bulkhead could pass down this hatch and on aft

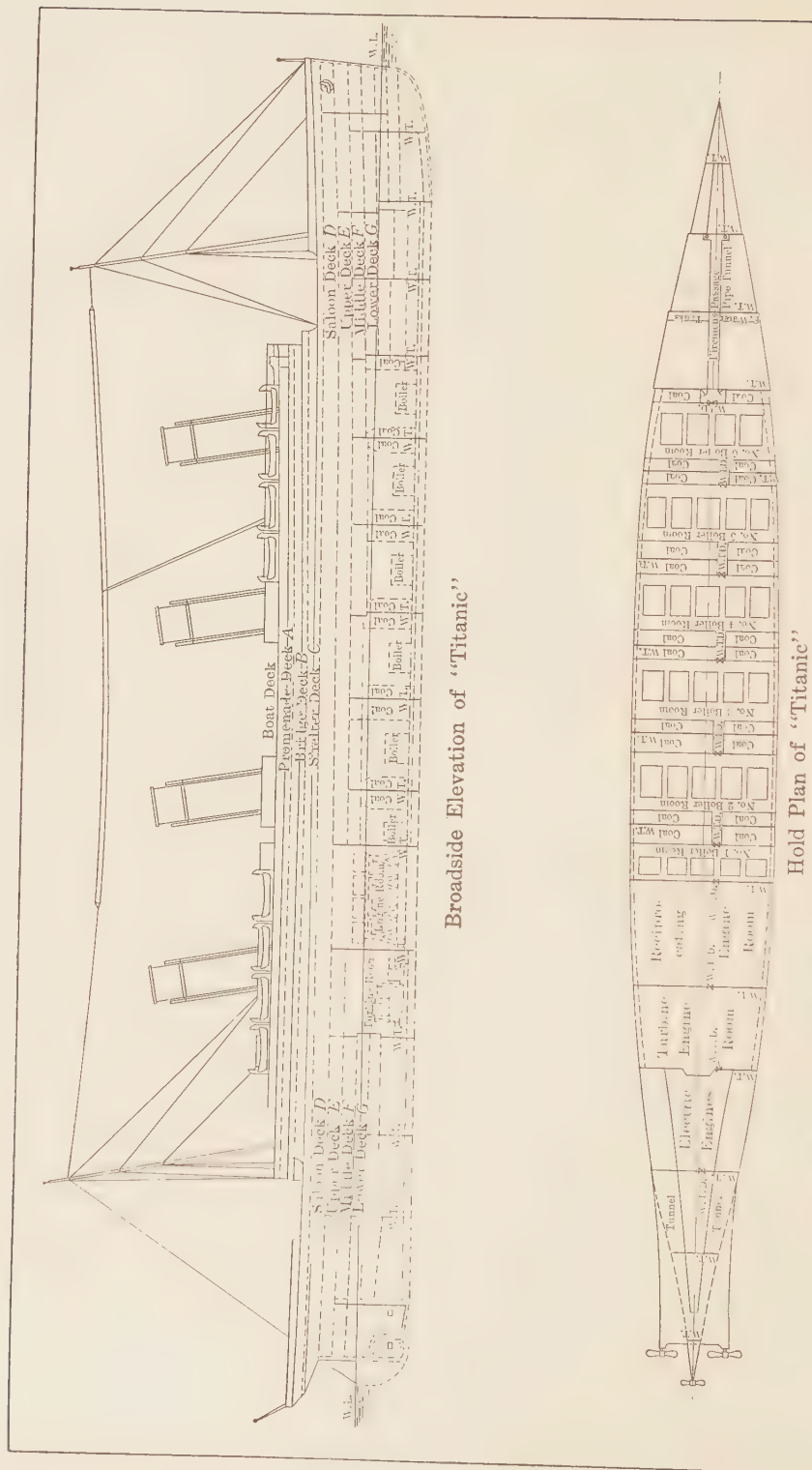


FIG. 3, 4. LONGITUDINAL ELEVATION AND HOLD PLAN OF THE "TITANIC"

through this passage into the forward boiler room if the water-tight doors were open. This door, being the main exit and entrance for firemen, could be counted on to be found open as the testimony indicated it was.

The filling of the forward boiler-room, added to the compartments already flooded, would cause the bow to sink yet deeper to below the level of the so-called upper deck at the second boiler-room bulkhead, so that water passing freely aft on this deck would then flood the second boiler compartment from above; then by the same process would gradually reach and flood the third boiler compartment from above, then the fourth and so on, finally sinking the ship by the head, all the incoming water fed by a comparatively small breach in the bow flooding the great body of the ship, not from below, but from above, because the bulkheads were so inordinately low compared with the length and depth of the ship and because the deck forward was not really watertight in its construction. The same result would have been brought about by damage to bulkheads 1, 2, and 3, except that boiler compartment 1 also would have been flooded from above if it were not flooded from the firemen's tunnel.

It is clear that the ship went down in this general way. Taking account of the long time between striking and sinking, and the probable depth of the injury, the mean effective area opened to the sea could not have been more than ten square feet. It would be more reasonable to omit the water-tight bulkheads altogether and rely upon the improbability of a collision than to go to the expense and pains of building the bulkheads and to leave them ineffective by omitting a few feet additional to their height. Bulkhead 2 should have been carried

continuously to the shelter deck, the real upper deck, and all other bulkheads except perhaps numbers 7 and 8 should have been carried to the saloon deck. In addition, the lower deck forward of bulkhead 2, should have been a real water-tight deck. In fact, this deck might well have extended to bulkhead 3 or even to the forward boiler-room bulkhead. A glance at Figure 4 shows that practically all of the bulkheads have doors intended to be water-tight but in reality a serious menace. Of course these doors facilitate passage back and forth, but they undermine the integrity of the bulkhead system. Certain of the bulkheads, like the forward boiler-room bulkhead and after engine-room bulkhead, ought to be solid.

The small percentage of lives lost in ocean transportation to the total number transported justifies evolution in the direction of cheapness and simplicity. I am convinced that high-grade transportation can be supplied on a cheapness of construction like that of the "Titanic" with safety more than abreast of safety and transportation on land, providing such slight modification and changes in water-tight bulkheads and water-tight decks are made as pointed out above—changes of a simple nature the cost of which could be easily made up by cutting down fittings whose sole purpose is luxury and ostentation. This, however, would not be the highest grade of transportation to be realized. A factor of safety considerably greater could be realized with much higher speed provided a more expensive construction is followed, with a full water-tight deck and longitudinal bulkheads, approaching that of war ships. Capable of floating under serious damage, such vessels would really be unsinkable in passenger service.

The increase in speed and the increase in safety entail very substantial increase both in cost of construction and cost of operation, since the speed is already great and the safety already reasonable in the other class. It is a question whether this highest class of transportation could maintain itself under the competition unless there were governmental service and governmental compensation.

The higher class would be so greatly superior for auxiliary naval purposes, and the need of such auxiliaries in time of war is so great, that every maritime nation would find it economical and in every way advantageous to offer the added inducements. Indeed, in time of war navies have larger needs also for additional auxiliaries for low-grade transportation of troops, coal, and supplies. Certain simple changes in construction would add so materially to usefulness in this service that the maritime nations would be justified in offering similar inducements for these types also. Vessels of all types thus adapted to governmental uses would be of particular advantage to the United States, where the Navy is seriously lacking in auxiliaries, and the ocean merchant marine so meager for supplying auxiliaries in time of war. The simplest and best form for such governmental compensation would be a percentage on the first cost, graded for the type of vessel and for its age. There is now before the Naval Committee of the House a bill of mine drawn along these lines, to avoid a subsidy as such, but to make up in part for the added expense due to meeting the governmental requirements. The yearly compensation varies from a maximum of 12 per cent

of the original cost during the first five years, for vessels of the highest class, down to the minimum of 2 per cent for the third and last five years of vessels of second class.

Even in the bulkhead and deck provisions against damage, the personal equation enters largely in the operation of water-tight doors and hatches. Well thought out regulations should be adopted and regular practice be held in closing these doors and coverings. The testimony in the hearings indicates that this factor was neglected on the "Titanic," due in part no doubt, to haste in putting the vessel in commission.

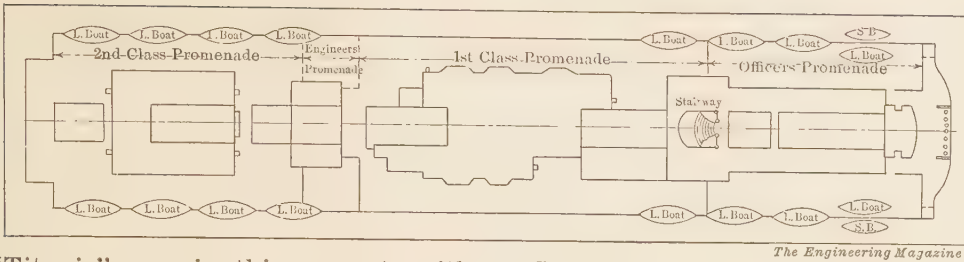
HOW TO REDUCE THE LOSS OF LIFE

The final consideration in safety at sea consists in provisions for reducing the loss of life when the vessel does sink. The first factor is aid from other ships. This can be largely developed by regular wireless communication with all vessels within a reasonable distance, and by vessels of similar speeds running in pairs as consorts for each other.

The second factor in importance is provision for saving life by boats and rafts. The minimum provision should be a seat in a regular life-boat, regularly manned and equipped, for every passenger on board. A ticket, by law, should entitle the purchaser to this seat and should specify the boat and seat. Provision should be made by law for mustering all passengers at their boats and seats before sunset of the first day out. The boats should be of strong build, to carry their full load of passengers when loading from the deck, and should be provided with mechanical lowering and detaching apparatus.

Figure 5 shows how delinquent the

*Further reference will be found to this subject in the Review of the Engineering Press, page 448 of this issue, showing a practical scheme for carrying a larger equipment of life-boats on a vessel of the "Titanic" type. It will be of interest to compare the illustration there with Figure 5 in Captain Hobson's article.—Ed. E. M.



"Titanic" was in this respect, with only sixteen regular boats and two whale-boats ready on the davits, and four collapsible boats, and with provision for only 1,200 persons in all, when she could have carried without inconvenience two to three times as many.

Being short of boats has become a custom at sea, the natural result of the improbability of any need for abandoning ship. Nevertheless, a regular life-boat seat for every life on board is a minimum dictated by reasonable precaution. Moreover, a regular detail of passengers to the boats should be made and a muster held. If this had been done on the "Titanic," there is no doubt that five hundred more lives would have been saved. In fact, the sea was so calm and the time of sinking so long, that with a full complement of boats and a proper station bill, it is likely that nearly all would have been saved.

The importance of life-boats, however, is likely to be overestimated in the public mind. If even a moderate sea is running, the difficulty of lowering boats is greatly increased and the chances of remaining afloat in the sea very much reduced. In order to realize such chances as there are, it is important that at least three of the men in each boat, and preferably five, should be experienced seamen, and one of them an experienced coxswain. The men in the boats of the "Titanic" left much to be desired in this respect, though, fortunately, there was no test in skill and seamanship.

In addition to the regular life-boats, the vessel should have life-rafts sufficient to carry all on board. I doubt whether the expense of fitting up a deck-house, as has been suggested, would be justified in view of the very small chance of ever having to use it, but the first-class ocean liner should have a full equipment of rafts of large size that would float off if not launched.

CONCLUSIONS

(1) The most important matter connected with the "Titanic" disaster is that ship-owners and ship-builders and marine engineers should not be given a setback in developing ocean transportation.

With reasonable precautions, the dangers incurred are practically negligible. Nothing in the disaster would warrant any cessation in the increasing size of vessels. The dead hull weights are as a surface, varying as the square of a linear dimension, while the useful weight is as a volume, varying as the cube of a linear dimension. Therefore, the larger the vessel the greater the useful carrying capacity in proportion to cost. Nothing in the disaster would warrant falling back to lower speeds. With the turbine engine and the developing gas engine, there is ahead a promising field for speed development.

(2) The governments of the world getting the advantages of higher types should encourage, by financial assistance, the development of such types, in higher speed, in greater size

and strength, and safety of construction. Legislators should not raise heavy barriers in the way of ocean navigation, but by international agreement should adopt uniform regulations for simple, effective precautions*.

(3) For first-class passenger vessels, transverse bulkheads should be spaced not over 6 per cent of the vessel's length apart on the average, and should rise not less than three full deck spaces above the water line at the ends, and at least two full deck spaces amidships. Bulkheads should be pierced only when imperatively necessary, and water-tight doors should be made efficient. The deck nearest the water line, forward of the boiler-rooms and abaft the engine-rooms, should be thoroughly water-tight.

An inner skin should be worked over the bottom and up the sides as far as the deck nearest the water line in the engine-room and boiler-room spaces and for at least half the distance from these spaces to the ends.

With these simple precautions, the "Titanic" could not have sunk.

(4) Better precautions against fire should be inaugurated in these high-class vessels and useless inflammable accessories of ornamentation and luxury should be omitted.

(5) Precautions should be taken to reduce the chances of collision with ice, derelicts, and other vessels, by concerted action in the choice of lanes, the running in pairs, the developed use of wireless, the patrol of danger spaces, the slowing down in fog and at night, in heavy weather, the better use of signals and lights.

(6) Life-boat provision and assignment should be made for all lives aboard and muster for abandoning ship should be held upon departure. Large life-rafts, capable of carrying all on board, should also be provided.

(7) The officers should be men of high standards of training, skill and experience, and the crew should be kept in a high condition of discipline, and should be exercised periodically in fire drill, closing water-tight doors, manning and lowering boats; and the use of beverages containing alcohol should be as carefully prohibited among officers and crew on board as it is on railroads.

(8) Let no one be intimidated. Man has the ocean under complete subjugation. Added to the lessons from the inanimate materials of ship and equipment is the great lesson for all in the conduct of men and women on board—namely, that the spirit is supreme over circumstances, and next to knowing how to live is to know how to die.

*It is of much interest in this connection to compare Dr. Soper's constructive suggestions for an international maritime conference immediately following Captain Hobson's article. Dr. Soper's proposal was independently developed, and, indeed, was in type before Captain Hobson's manuscript was received.—
ED. E. M.



THE EFFICIENT MANUFACTURE OF RAILWAY TRANSPORTATION

By Harrington Emerson

One of Mr. Emerson's ablest reviewers recently expressed a hope that, as his first book has been a declaration of a philosophy and the second a definition of principles, the third might be a description of practice animated by the philosophy and guided by the principles of efficiency.

Meantime events were working toward this very result. The example is not one with which Mr. Emerson has been professionally connected. It is wholly free from any personal relation. It is a railroad in which ideals of relations to the public, of personality, of organization, of equipment and operation, were determined by the management through their own discernment of the fundamental truths on which all efficiency rests.

Mr. Emerson was placed on the inside of the workings of this road. By the courtesy and co-operation of its officials he was brought into intimate contact with all its problems and conditions. From this point of view he will show how excellent a realization of the principles and the precepts of efficiency may be secured and is secured in the operation of the line in question—the Pittsburg and Lake Erie.

The points of success will be emphasized by contrast with the points in which success is imperfect or is lacking. The result will be not a theory of operation, but a demonstration from the actual thing itself. The article this month sketches in the background of the picture by displaying concretely certain corporations' ideals of public service as shown by their treatment of the public.—THE EDITORS.

DURING the last five years there have been outbreaks of great hostility against the large corporations. The corporations have been both surprised and grieved. They have been conscious of the great advances they have made; they, better than anyone else, knew the cost in money, in effort, of these improvements, and they could not understand the hostility.

They called it muck-raking, ascribed it to the pernicious activities of certain writers and to the love of sensationalism of certain periodicals, unmindful of the fact that no deliberately set fire can kindle a great conflagration in a desert.

The builders of modern buildings attempt to make them fireproof; they patrol them by their own watchmen, they do not trust to the police to arrest incendiaries nor to the fire department to extinguish. A building like the Equitable burned down because it was not modern. Have the great corporations shown the same

skill in guarding against moral incendiaries and against brain-storm conflagrations?

I can largely sympathize with the surprise of the corporations because I have had a similar experience in my own work of applying Efficiency Principles to modern industry. Some erroneously confound Efficiency Principles with "Scientific Management" which uses only some of the principles, not all. Science is a good thing. Science is young. It has made more strides in the last fifty years than in the previous fifty centuries. Even the last ten years have revolutionized our conceptions. The discovery of radium and the invention of wireless telegraphy are more than episodes. To break up the atom into corpuscles is as great an advance as to realize that the sun, the moon, and the stars were not lanterns hung on a large tent wall, but separate worlds in infinite space. To trace diseases to the multiplication of infinitely small living beings is ob-

vious, yet even yet scarcely accepted. That magnetic oscillations return to the earth like a shot arrow instead of vibrating like light in a straight line out into space, makes us pause and wonder whether light may not also travel in immense parabolic paths. Take modern science out of our lives, and we would drop back a hundred years and as far as any real difference exists, we might drop back five thousand years, for the civilization and culture of Egypt, of Mesopotamia five thousand years ago was superior to that of London, of Paris, of Rome one hundred years ago. Science is our best servant. Management is also always a great essential. It means the family instead of promiscuity, it means the army instead of the mob, it means order instead of anarchy.

Scientific management ought, therefore, to be a most excellent combination to which no rational being could object, especially as scientific management was known to produce marvelous results. Yet, somehow or other those who would be most benefitted by scientific management, the great employers of labor, the railroads and the great labor unions, became hostile. No "scientific management" for them. It is evident that this hostility cannot be either against science or against management, to which separately we owe all the material part of modern civilization. Therefore, those who had successfully demonstrated the value of scientific management in modern operations were surprised and grieved at the hostility shown, but instead of continuing to be surprised and continuing to shed tears it became necessary to find out what it was that caused hostility, since in spite of the words used neither science nor management was guilty.

All of us want efficiency in our in-

terest, not at our expense. The principles which when applied result in efficiency, are necessarily divided into ethical principles and into practical principles. This division is fundamental. Practical principles are not opposed to ethical or moral principles, nor are ethical and moral principles opposed to practical principles; but the practical principles which particularly underlie scientific management may be just as much instruments of destruction as of construction, if they are not combined with the entirely separate moral principles. Moral principles, on the other hand, are excellent in themselves even in the absence of science and of management. Those who thought they felt in scientific management a submergence of moral principles, naturally revolted, temporarily combined with those who antagonized science and management because their own pickings lay in the wastes, which are due to the absence of science and to the absence of management. These distinctly selfish antagonists hide themselves behind the ramparts of those who objected to the apparent neglect and omission of moral principles.

As an indication of the extent to which practical principles may increase danger, we need only refer to the wreck of the "Titanic." In her operations every practical principle was observed and every ethical principle neglected. The practical principles were all in force. She had been splendidly planned, every operation had been scheduled and accurately despatched, conditions and operations were standardized, instructions were specific, records were reliable, immediate and adequate.

The ethical principles were, with one exception, largely ignored. The ideal of safety was wholly subordinated to speed, to luxury; common

sense was non-existent. A steamship does not at night fling ahead at 21 knots or more when in a well known field of ice. Definite counsel as to location of the ice, and even more definite counsel given last November by Capt. Roden in "The Navy" was disregarded. The fair deal to passenger and crew alike, who had a right to expect that speed and luxury would be additions to, not substitutions for, safety, was ignored. Discipline alone of the moral principles prevailed, because discipline even more than safety is the oldest principle of the sea. There were no efficiency rewards for acts showing compliance with the essential ideals. The 1,635 perished not because the lifeboats were too few. A Cunard steamship is safer without lifeboats than some other steamers with a cargo of them. Noah's ark had no scientific management, conditions and operations were both most elementary, not to say horrible, its plan was poor, its journey was neither scheduled nor dispatched, the ventilation was very poor, but Noah had an ideal, one ideal—safety. He took advice when it was given, he used all the common sense he had, he maintained discipline, he, in the quaint practice of his time, gave an efficiency reward to the Lord and through it secured a promise that the earth would not be destroyed again.

Noah's ark was safer than the "Titanic" because morality without science is always safer than science without morality.

The teachers of scientific management have not been negligent of the ethics underlying practice, but some of their followers have, and even the teachers have unfortunately magnified the practical rather than the ethical gains. When a man hears that he can do four times as much work, he and his employer also are apt to think that he must work much hard-

er. If he had been asked whether he would prefer to run an automobile a few hours a day and draw \$4 or drag a rickshaw 10 hours a day for 10 cents, he would recognize that the ethical gain of lessened exertion, lessened fatigue, of more leisure, of more pay, was of even greater value than the increased output. It is because the rickshaw man pulls only 200 pounds at 4 miles an hour that he has to work hard for long hours. It is because the chauffeur, using his supervising skill, hurls the automobile weighing, with passengers, 2,000 pounds, 40 miles an hour along a road, that he is able to command leisure and high wages.

The difficulties, the prejudices, that modern efficiency teachers have encountered from the just indignation and alarm of the public at perversions of the new methods, railroads and other large corporations have encountered not on account of their virtues but on account of their faults; and it is their faults, their real faults, that inspire antagonism even if the unthinking attack the virtues instead of the faults.

To test out the attitude of mind of managers of great corporations towards the public, I recently seized on trivial occurrences to make protests and see how they would be received and met. It is, of course, always easy to find occasion for offense, very real offense. Offenses of this kind must occur by the millions, and each offense will recur unless its distant cause is remedied, thus stopping not only its source but that of hundreds of others. Offense engenders hostility which very rarely becomes articulate. The victim waits until he has a chance and he then delivers a flank attack.

There are army officers, martinets, who exasperate the rank and file in times of peace and who are the first

killed, from the rear, in time of war. In Germany recently a private shot an officer during parade and immediately killed himself, thus escaping court-martial and execution, but the highest military authorities seized on this episode to caution all officers to use a less exasperating manner towards those whom in point of fact they were to serve, to encourage.

My experience testing railroad officials will serve as a preface to the concrete study of the ethical and practical excellences of the road which is to be the central subject of these articles. It will fill in the background against which the individual case is to be displayed.

A lady bought a return ticket from the Pacific Coast to Buffalo. The ticket had to be validated in Buffalo before return. She came through to New York. Returning, she wanted to take an express train passing through Buffalo at 2 a. m., a most inconvenient hour for an invalid to leave the train and go to a ticket office. I asked that either the validation be made through the New York office, or the agent at Buffalo go to the train. Both requests were curtly and insultingly refused. I appealed to the general ticket agent, and he at once took every pains to accommodate the traveler, utterly repudiating the boorishness of the underling. Had I not made the protest, the traveler and all her circle of friends would forever have nursed a grievance.

I stumbled in the dark over a water pipe at the top of a station flight of stairs down which I pitched. As a man-trap the arrangement was unusually effective. I wrote to the general manager, who at once replied stating that the laying of the pipe was due to the carelessness of a workman and that he would have it removed. He thanked me for calling his attention to the danger.

At Long Branch early on July 4 I bought two tickets for Philadelphia. While I was buying them the train pulled out. I asked the ticket agent to redeem them, saying that I would buy tickets to New York instead. He replied that redemption would be impossible and that I would have to send the tickets in to the central office. If I had been a poor Italian bent on a holiday this would have been a monstrous inconvenience. The rule was, in any case, not inflexible, for the next week, as a test, I asked for two tickets to Philadelphia and after they were issued and handed out, I refused to pay for them and handed them back, enquiring how he would fix it up. The superintendent of the road wrote me that the agent was quite right in refusing to redeem. This was evidently one of those cases where some minor clerical convenience to the railroad is given preference over ethical rights of the traveling public.

Being in the Twentieth Century train of the New York Central I gave the Pullman car porter a day message for Chicago. Western Union stations are, as far as I know, the only telegraph stations on the New York Central lines. The Pullman car porter charged me the full rate for the long day message. It was delivered in Chicago as a night letter, too late for the recipient to meet me. The family where it was delivered tell me that it came on a Western Union form. At once I called the attention of the Western Union to this double offense, the extra charge and the late delivery. At intervals through the year I repeated the complaint. At the end of thirteen months the vice-president wrote me:

We have no record of having handled the message. If you know it to be a fact that the telegram delivered to your brother was a Western Union message, I shall take

pleasure in refunding the amount which you state was paid in tolls, in view of the probability, though it has not been demonstrated as a fact, that our people rather than the railroad employee to whom you entrusted the message may have been at fault.

This letter shows absolute misapprehension of the reasons for my complaint which was not the loss of a few cents.

There were three sensible courses of action open to the Western Union Company, any one of which would have been satisfactory.

(1) Prompt attention to my complaint, meeting it by reparation without further enquiry as to whether I was right or wrong. I at least would have been quieted and subsequent investigations could have been made without involving me.

(2) A prompt and definite statement that the company could not be responsible for messages delivered to train employees, that they were my agents, not the agents of the Western Union.

(3) A prompt refutation of my statements.

This was what was attempted, but the delay, a whole year after the occurrence and after the initial complaint, made it impossible for me to produce either the railroad employee or the message itself.

Leading from another railroad station was an outward swinging door with a step for the threshold. My wife, not seeing the step on account of the closed door, stumbled down it and was slightly injured. I complained. The vice-president of the road ascertained that about 200,000-000 passengers had passed through that door and over that step without complaint. The statistics were certainly against me, but it was not on statistics I was relying. Statistics could have been quoted against passengers on the "Titanic" com-

plaining of insufficient lifeboats, absence of searchlights, etc. My complaint was made for two reasons. First, to see whether the railroad company, so very progressive in other directions, would correct, if it could do so without much trouble or expense, what had injured even one in two hundred millions, and also whether the railroad had a policy of receiving and tabulating suggestions of other kinds, reasonable and unreasonable, so as to maintain closer touch with the public. In a larger sense the railroad is ours. We may own shares in it, we travel on it, we see its trains go by, and we must feel either friendliness or hostility towards it, and friendliness is a tremendous asset for any corporation.

On a Friday I bought a night ticket from New York to Lewiston, Me. I missed the train. It was nearly midnight. I resolved to take the midnight train to Boston. Ticket offices for both sleeping car and train refused to redeem my tickets. I was told I would have to send them to New Haven. To me it made no difference, but what about some poor fellow trying to join a ship at Portland, stranded in New York at midnight, unable to get his money back until the following Tuesday?

I wrote the general passenger agent, an old friend. He answered that it was not customary to redeem tickets except through headquarters, that he knew of no railroad which did, but he also told me that if I had called him up at midnight by 'phone he would have fixed the matter for me. This was delightful. I was not thinking of myself. I was thinking of those less independent and without friends at court.

There may be good reasons for many exasperating regulations, promulgated with a sole eye to the con-

venience of the railroad. System is necessary, but the more perfect the system the more need is there of a broader spirit and interpretation. One of the great Chicago mail-order houses was spending \$85,000 a year to keep a record of all shipments. It found that it refunded in complaints about \$25,000. It abolished the \$85,000 office and assumed that all complaints were well founded. It was a cheaper method and also very soothing to those who made complaints.

A great department store had one rule as to all complaints—the customer is always right. Is it not on account of this attitude towards the public that there is so little hostility towards department stores? Small tradesmen in small towns would like to suppress them, but the great public they serve is distinctly friendly.

Early this spring I found it necessary to make an emergency run in shortest time from New York to Pasadena. I secured tickets on the Pennsylvania Special with one-half hour for connection across the city of Chicago to the Santa Fe Number 9. The Pennsylvania Railroad is probably the most thoroughly systematized corporation in existence and makes every effort to run its 18-hour special on time, nevertheless I wired to the general manager telling him of the great importance the connection at Chicago would have for me and the appreciation I would feel if the usual Pennsylvania record were maintained, the disappointment I would feel if any untoward occurrence should make the train late.

The manager might have considered my wire impertinent, he might have answered that the Pennsylvania always ran its trains to the best of its ability, he might have made me feel that he would not even consider such an insignificant unit as one of a hundred-thousand passengers. In-

stead, as I stepped on the train at Manhattan Transfer, the conductor came to me, asked my name, told me he had a message from the general manager to assure me that notice had been sent out over the whole main line of the special importance of maintaining the schedule. Up to Fort Wayne the train ran on time, but after that, by a lame fast train ahead, was delayed to such an extent that the connection would be missed. The train officials came to me, told me of the messages they had received, said they had arranged to wire to the Santa Fe asking that road to hold its fast train the few minutes necessary for me to cross the city. As we passed Englewood there was the New York Central Twentieth Century equally late. Reaching Chicago we were met by a Pennsylvania official, who had a taxicab reserved, who was ready speedily to transfer baggage, who opened private gates and we were wheeled across the city, the Santa Fe train being held fifteen minutes to accommodate two unnamed passengers.

It was important to me to make the connection, but that two of the greatest railroads in the world should have made my little affairs their own, should have extended me their exceptional solicitude, filled me with admiration and affectionate gratitude. Were either corporation to be attacked, even justly, my feeling would be: "Nevertheless, they *do* care for their patrons."

A wee woman hurrying timorously from Boston to Detroit, when the train stopped at a junction, walked up to the engine to see what kind of a man she was entrusting her life to. The big engineer smiled out of his cab at the little bit of humanity looking up doubtfully at him, she smiled back and enquired whether he would take the train safely through

on time. He, whose run stopped 500 miles short of Detroit, assured her that he would, that she need have no fears, and, comforted by the thought that the big man was personally taking care of her, she returned peacefully to sleep the night away. It is not these kindly acts, it is the spirit back of the acts that endears.

Railroads are indispensable; they do a great work fast and economically. The business of railroads is transportation; this is what they manufacture with a smaller percentage of waste or loss than any other manufacturer. Other manufacturers buy raw material, add to the value, and then sell again. This was originally the function of transportation. Slavers bought human beings cheaply in Africa and sold them dear in America. The business was distinctly one of transport alone. The shrinkage and waste was terrific. Until the railroads were built most merchants transported their own goods. It could hardly be determined whether the transportation was incidental to buying and selling or the buying and selling were incidental to transportation, but by camels on the desert, in merchant ships at sea, and in freighting wagons on the plains, transportation was the more important function.

Railroads are as fine and as necessary as the great ocean liners; but just as surely as either, in operation or in their relations to their employees, to the public and to the commonwealth, do not apply the ethical principles, they court disaster.

It is, of course, easier to criticize than to put into effect upbuilding initiative, but one wonders why railroads antagonized trolley lines instead of seizing on them as valuably supplemental to their own trunk system; one wonders why railroads were not the first to use auto-trucks to dis-

tribute and to collect freight, making for this purpose house-to-house calls; one wonders, when one sees how admirably the Hudson Terminal system serves principally the Pennsylvania, but also other roads, that similar methods of perfecting the delivery and collection of passengers were not long ago developed. One wonders that the railroads have not to a greater degree realized that up to the present there has been a race between their own growth and that of the country, and that the country has grown faster; but just as soon as the rate of progress of the country begins to slow down, the railroads will face a crisis, which is already dawning. When there is no more land the price of farm produce will rise; every other manufactured product will become dearer only as the supply of raw materials is exhausted; but railroads are essentially like ships which must earn enough during their short lives to pay for their replacement.

The assets of the Cunard Company are today their existing ships, not ships long ago obsolete, nor has the Cunard line been able to capitalize the lanes of the sea; but railroads are now expected to rebuild and re-equip throughout and to furnish better service for less than they formerly charged. Why? Because trolley cars and perhaps auto-trucks on good roads can afford to carry all but the lowest-grade long-distance tonnage at present railroad rates.

There is a railroad in the United States that perhaps more than any other has applied to its operation and management both practical and ethical principles, that has both kept in the forefront of modern railroad practice and also secured the friendship of the community it serves, of its patrons and of its employees.

The next article will take up its ethical strength.

MODERN ORGANIZATION

By Charles Delano Hine

VI.—LINE AND STAFF.

Major Hine's most interesting and thought-stimulating statement of a new view of modern organization began in our January issue with an outline of the "unit system" as applied on the Harriman Lines. His second paper, "Broadening the Ideals of Line Supervision," emphasized the reasons for the effectiveness of some of the measures defined in the first. The third installment attacked certain fundamental characteristics of ordinary present-day practice, pointing out that even the cherished institutions of efficiency must be balanced by complementary forces if the true path of progress is to be followed. With increasing definiteness, he then applied this argument to the specific cases of accountancy and permanent special staff, offering a new interpretation of the nature of both functions and new suggestions for their administration to the greatest advantage of total efficiency. The same illumination from a new point of view was then turned upon the purchasing department and now a characteristic and interesting concept of the functions and relations of staff and line rounds out the discussion of departmental relations. The following part of Major Hine's series will take up the genesis and evolution of organization.—THE EDITORS.

KNOWLEDGE is power. Knowledge of the principles governing line and staff in organization is often sadly lacking in the training of executive officers. The sins of ignorance are costly. No field of investigation will yield a larger return in efficiency than that of line and staff.

Line functions are those exercised in direct sequence through prescribed and definite channels of authoritative control. The first line officer had no staff because he had time to do both the acting and the thinking parts. As the activity grew in volume, the responsible line head found the necessity for expert advice. Perhaps this came from a lawyer, a surgeon, or an engineer. Whatever the source, there was no suggestion of turning over to the expert adviser the direction of the activity itself. In a less highly organized condition of society the distinction was easily maintained. The lawyer, the surgeon, or the engineer might have many clients. This divided patronage rendered it mani-

festly impossible for the outsider to become responsible for direction of internal affairs. In the modern corporation it frequently happens that the amount of expert attention demanded will justify engaging the expert to devote his sole attention to the corporation in question. Then the trouble begins. Human nature is such that, unchecked, its ambition leads to meddlesome interference with specific matters beyond its immediate concern. The problem of organization is to impose such checks and balances that each component of the activity will maintain its proper relation to the others.

Staff as contra-distinguished from line originates in the necessity for maximum intellectual attention untrammelled by the demands of administrative routine. Here is a distinct differentiation of function. The officer absorbed in directing large affairs, in getting things done, is of the line. For the time being at least he is too busy to originate better methods or to seek the principles underlying his activities. He

is the operator rather than the inventor; the actor rather than the playwright. Science and invention add to the complexities of the art and force the necessity for expert assistance.

The old sailing masters had to be reinforced by engine experts when steam was applied to navigation. Fortunately, the law of the sea demands undivided control in the sailing master, and the marine engineer has always been subordinate to the captain of the ship. Until recently this subordination has been too intense. The marine engineer in a staff corps was out of line for promotion to the captaincy. Perhaps the chief engineer was twice as good a man as the first officer, and perhaps had double the service, but higher than a chief engineer he could not go. Since the splendid progressive amalgamation of the staff steam engineers of the United States Navy into the navigating line, the specialist in engineering finds no hatchway permanently battened between the engine room and the deck. Under the old order of things, there was before a strong man in the engine room a constant temptation to fortify himself behind the technique of his specialty at the possible expense of navigation itself. Now that he is a navigating officer, the direct purpose of the ship, namely navigation, is constantly most prominent. Engine rooms exist to propel ships. Ships do not exist to contain engine rooms, except incidentally.

The recent Titanic disaster has called public attention to the failure to observe the old-time custom of developing all-round men at sea. There were not enough real sailors to man the life boats effectively, and stewards and stokers proved poor substitutes for sailors. This can be traced to the failure on the modern

steamship to balance line and staff, to check over-specialization, and to remember that the ship, the whole, is greater than a department, one of its parts. The remedy does not lie necessarily in increasing the number of sailors as such, but rather in rotating stokers and others with sailing duties and rendering them available and more effective in time of need. This means more trouble for responsible heads, more work for officers in educating and training their men. Such increased work is what officers are for. Such constant incentive to endeavor prevents sluggishness and inaptitude for emergencies.

The first staff officer had no authority beyond that of polite inquiry. There was no one whom he could command. Gradually he acquired an office force and assistants. Not satisfied with telling others how to do, he unconsciously began doing things himself. He thus became a line officer burdened with administrative routine precluding proper concentration on that thinking part which the staff officer was himself created to perform. The controversies between line and staff in the Army and Navy of the United States have cost our Government untold millions. Most of the railway and industrial corporations of the United States are wasting some money every day by permitting staff officers to attempt to exercise line functions. The Army and the Navy have found an effectual check by going back to first principles, by amalgamating staff and line, by judicially rotating function, and by substituting periodic details from the line for permanent appointments to the staff.

Such solution is so logical and so practical that it is attracting the attention of the railway and industrial world. As the subject receives

the attention that it deserves, the practical application of the principles involved will be prompt and intelligent. So one-sided has been the training of executive officers that most of the so-called captains of industry, narrowed by specialized training, must perforce consume much time in studying subjects previously outside their scrutiny.

Training leaves its marks. A lawyer, called to an executive position, often fails to see the necessity for the direct and ever-present sequence of authority. If all the judges of a city leave town for the week end, little harm may result. So unusual is an application out of regular hours for a writ of injunction or a writ of habeas corpus that the inconvenience of securing a judge would not be serious. Industrial concerns and railways, however, run every day in the week and every month in the year. There must ever be an alert and present incarnation of administrative authority. These administrators are like the firemen and the policemen of a city. There can be no haphazard, indefinite "take it up next week" method of procedure.

Constitutions of Governments follow scientific differentiation of function. The executive is a line function, continuous in effect and direct in action. The judicial is a staff function, more or less continuous in effect, and presumably operative not directly, but through the executive function. The legislative is a staff function intermittent in action and indirect in the application of its conclusions. Frequently there is a departure from these scientific planes of cleavage and harm results. Just at present the Federal courts are engaged in a futile effort to exercise the line functions of not only regulating but administering numerous great corporations. The fundamen-

tal defect is the same as exists in receiverships. When the court attempts administrative functions, there is no tribunal for judicial review of its own acts. As this principle is understood, receiverships will be supervised by some executive arm of the State, as is done in the case of banks both by the Federal Government and some of the State banking bureaus. Receiverships are seldom denied, for the reason that judges, being human, covet power. Were the receivership ordered by the judge to be conducted by someone else than himself, there would be greater probability of real judicial action on his part. No military commander of modern times has dared exercise the despotic authority that often characterizes a court in conducting a corporation receivership.

The staff function of greatest vital necessity is that of inspection or review. The tendency of inspection is that of extremes. Inspection reports often become perfunctory and colorless. On the other hand, they may be hypercritical and demoralizing. True inspection is as open as the day and as welcome as the evening. True inspection makes the persons inspected grateful for the inspection. The true inspector is so thorough in his training, so secure in his knowledge, so considerate of his subjects, so forgetful of himself, so devoted to his duty and so worthy of respect, that those whom he inspects pay the unconscious homage of admiration. Such men are rare, but they can be developed. Experience has proven that there are definite limits of time within which an officer can be assigned to staff inspection duty. Some return to the line is essential to retain that human touch with everyday requirements through which alone can the confidence of others be merited.

An important component of inspection is audit. As previously stated, accounting frequently attempts to do duty as auditing. This is another instance of failure to differentiate between line and staff. Accounting is a line function, a part of operation. Auditing is a staff function, a part of comprehensive inspection.

All positions contain their characteristic tendencies and inherent temptations. The line officer, because he is practical and direct, is often impatient of staff suggestion, which he regards as fantastic and theoretical. Too often this prejudice is strengthened by the unfortunate mental attitude of the staff expert. Men who think out of and away from conventional grooves have usually a unique personality. Too often this is coupled with overbearing intolerance for their less gifted brethren. With personal eccentricities that are but manifestations of narrow selfishness, the cause of efficiency has had to struggle against the handicap of the unfortunate personal equations of some of its ablest exponents. Tactless, intolerant, and inconsiderate treatment of conscientious line officers has discredited many an honest staff expert. The true teacher makes his students love their work and respect him because the work is lovable and because his teachings are sound.

The best antidote for the undesirable condition mentioned is periodic service in the line. It rounds off the square corners and bevels the sharp edges. The staff officer in turn is more valuable when fortified by actual line experience and accomplished results. It is always easier to tell the other fellow how than to do the thing oneself. The most successful man is he who has done both things, who has told and has done,

who knows how and who also knows why.

Staff and line functions are often confused because of a loose use of the overworked word "staff." It is entirely possible for the same individual to act both in line and staff capacities. Several line officers at the head of distinct departments or groups of activity may collectively constitute the advisory staff of their common superior. Each of the nine heads of the executive departments of the United States Government in Washington is a line officer exercising direct authority over hundreds or thousands of subordinates. Assembled at the White House, the nine become collectively the President's Cabinet, a staff body. The weakness of this governmental organization is the absence of a chief of staff, in effect an assistant president. An attempt is made to supply this defect by having a secretary to the President at \$7,500 a year direct and co-ordinate for the President the activities of nine strong Cabinet officers each rated at \$12,000 a year. The President of the United States is too busy a man to bring about complete co-ordination, and much goes by default. In recent months the handling of a delicate situation in Mexico has furnished numerous instances of a glaring lack of co-ordination between the State, Treasury, War and Navy Departments. This was the fault of a defective system rather than of individual shortcomings.

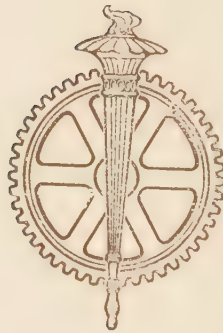
Evolution brings us back to first principles. In the first administration of George Washington, his Secretary of State, Thomas Jefferson, was, in effect, though not in name, prime minister and chief of staff. Foreign affairs were an incident of the State Department. Today the

foreign affairs of a mighty nation absorb practically the entire activities of the State Department. It no longer serves as a balance wheel for the other departments. The remedy is to create a Department of Foreign Affairs under a secretary, a member of the Cabinet, and to restore to the State Department many of its original functions. The secretary of State, in the same building with the President, would be the latter's assistant and chief of staff. The Department of State would, as its name implies, be the department of departments, balancing and co-ordinat-

ing the other nine. One of its functions would be that of inspection, including audit and review. It would include a comptroller who would audit the Treasury Department. The anomalous condition of having the Treasury Department audited by its own comptroller would be eliminated. The position of secretary to the President would join the scrap heap of discarded organization.

The greatest boon to modern organization is the chief-of-staff idea, scientific in conception, practical in application, effective in result and as enduring as eternity itself.

(To be Continued.)





SHOPS OF THE PENNSYLVANIA STEEL CO., STEELTON, PA.

See also page 363.

COMPARATIVE COST OF BUILDINGS OF WOOD, CONCRETE, AND STEEL FRAMING

By Henry Grattan Tyrrell

Mr. Tyrrell's digest of comparative construction costs of industrial buildings as a whole will be followed by two articles devoted to the subject of factory floors, with description and discussion of all important types. While the main consideration throughout is given to physical elements, all are examined and judged with a broad recognition of total economy and efficiency in operation, taking into account not only first cost but maintenance and repair, and influence on the condition of the workers and the quality of product.—THE EDITORS.

THE most recent report of specific costs of reinforced-concrete factory buildings is that presented at the convention of

The National Association of Cement Users in March, 1912. These costs in detail are given in the following table:—

COST OF REINFORCED-CONCRETE INDUSTRIAL BUILDINGS

Type.	Size. ft.	Stories.		Live load	Kind of floor.	Column spacing. ft.	Costs.	
		No.	H'gt ft.				per sq.ft.	per cu ft.
							Dollars	
Machine shop.	50 by 120	4	12.0	150	Beam and slab.	10 by 24	1.17	.09
Cotton mill...	129 by 550	2	16	75	" "	10.8 by 25	.98	.07
.....	.....	4	12.6	150	Flat slab.....	17 by 20	1.09	.077
Weave mill...	60 by 140	5	12.6	150	"	17.6 by 20	1.50	.12
Knitting mill..	75 by 220	2	14	125	Beam and slab.	12 by 25	1.09	.073
Factory	56 by 223	2	16	300	"	18.6 by 18.6	1.55	.10
Weave shed...	231 by 341	1	..	125	Saw tooth.....	13 by 21.4	1.79	.07
Machine shop.	100 by 220	1	..	...	.....	20 by 20	1.75	.10
Storehouse ...	56 by 181	4	14.6	150	Flat slab.....	18 by 20	1.15	.07
" ..	109 by 580	10	12	250	Beam and slab.	19.3 by 19	.85	.071
" ..	.....	..	..	...	.....	.....	.76	.05
" ..	100 by 256	12	8	150	Flat slab.....	16 by 16.8	1.04	.12

From this table it appears that the average cost of single-story buildings with saw-tooth roof is \$1.77 per square foot of floor and 8½ cents per cubic foot of contents, while the average cost of buildings with more than one story is \$1.12 per square foot of floor and 8.7 cents per cubic foot of contents. These figures are on the complete building with plumbing, but they do not include heating, lighting, sprinkler system, elevators, or power equipment. The square-foot

prices were obtained by dividing the total cost of the building by the aggregate floor area including the basement, but not including the roof.

Another report on the cost of reinforced-concrete buildings read in 1909 before the National Association of Cement Users gives the specific costs of twenty-one buildings, showing an average cost of \$1.72 per square foot of floor area and 13.8 cents per cubic foot of contents, as follows:—

COST OF CONCRETE BUILDINGS

Type.	Place.	Total cost of building.	Volume in cubic ft.	Floor area, sq. ft.	Costs. cu. ft. sq. ft. dollars	
Store	Nashua	\$141,755	1,714,400	168,696	.0827	.84
Hospital	Buffalo	60,800	703,692	57,654	.0865	1.05
Office	Everett	61,646	496,780	39,840	.124	1.545
Cold storage	Boston	200,051	1,535,000	154,000	.13	1.30
Factory	Chelsea	19,292	212,400	15,000	.091	1.28
"	Cambridge	141,529	1,329,868	106,000	.107	1.335
Storehouse	Saco	76,796	1,140,000	146,000	.0685	.575
Factory	Providence	91,377	1,380,500	90,240	.067	1.01
Office	Jacksonville	136,880	693,840	56,552	.197	2.42
Factory	Cambridge	133,064	105,600	8,800	.124	1.485
"	"	75,604	1,211,364	75,604	.0625	1.01
"	"	23,332	180,000	16,394	.129	1.42
Office	Portland	181,194	1,365,800	90,474	.133	2.00
Factory	Greenfield	12,774	112,440	7,519	.114	1.70
"	Southbridge	44,652	746,674	49,546	.060	.902
"	Attleboro	39,830	312,000	24,960	.127	1.60
Garage	Brookline	10,436	156,198	10,806	.085	1.23
Filter	Lawrence	19,993	149,250	19,208	.134	1.04
Fire station	Weston	6,757	44,265	2,982	.153	2.26
Observatory	Milton	3,625	9,734	657	.373	5.45
Filter	Lawrence	20,076	59,991	5,243	.333	3.82
Average					.138	1.72

COST ANALYSIS OF FORMS AND CONCRETE; AVERAGE RESULTS

	Cost of Forms in Dollars per Square Foot of Surface				Cost of Concrete in Dollars per Cubic Foot in Place							
	Labor	Lumber	Nails	Total	Concrete Labor	General Labor	Cement	Aggregate	Teaming	Plant	Total	
Columns	.082	.036	.001	.130	.096	.027	.085	.049	.021	.023	.301	
Beam floors	.070	.045	.002	.116	.111	.020	.106	.063	.025	.024	.354	
Slab floors	.071	.038	.002	.111	.097	.009	.096	.070	.019	.024	.315	
Slabs only	.061	.032	.002	.095	.102	.019	.128	.068	.024	.017	.359	
Walls	.085	.036	.002	.128	.090	.016	.073	.076	.025	.019	.301	
Foundation	.068	.033	.002	.103	.076	.015	.080	.062	.019	.017	.269	
Footings	.057	.034	.002	.093	.045	.007	.071	.077	.007	.021	.229	



ABOVE, PLANT OF THE GENERAL FIRE EXTINGUISHER CO., WARREN, OHIO. BELOW, OF THE EDWARD
FORD PLATE GLASS CO., ROSSFORD, OHIO

The upper plant, shows United Steel sash outside of wall columns, extending in an unbroken line. The
lower shows the same sash in all sidewalls, monitors and saw-tooth roofs, with over 1,000,000 sq. ft.
of "Hy-Rib" concrete roofs. Trussed Concrete Steel Co.



A FERROINCLAVE SAWTOOTH ROOF, CONNECTICUT COMPANY'S CAR SHOPS, UPPER AND LOWER SIDES
The Brown Hoisting Machinery Co.

It appears therefore that the average cost of forms per square foot is for columns 13 cents, beam floors 11.6 cents, slab floors 11.1 cents, slabs only between steel beams 9.5 cents, walls above ground 12.8 cents, foundations 10.3 cents and footings 9.3 cents.

A subdivision giving the percentage cost of concrete, steel, labor and forms is as follows:

Concrete costs	19	per cent	of the total.
Steel	"	17	" " "
Labor	"	31	" " "
Forms	"	33	" " "

Total.....100 per cent

and basement and 500,000 cubic feet of contents, cost \$1.15 per square foot of floor, or 9.1 cents per cubic foot of contents. The floors were proportioned for a total load of 200 pounds per square foot, and the prices given above include excavation, foundations, walls, columns, floors, framing, roofing, windows, doors and stairs, but do not include plumbing, elevators, heating, lighting or partitions.

Concrete factory buildings from one to five stories in height and about 50 feet wide will have minimum costs about as follows:

	Cost per square foot of floor area	Cost in cents per cubic foot of contents
3, 4 and 5 stories.....	\$1.00 to \$1.10	7.5 to 8.5
2 stories	1.05 to 1.15	8.0 to 9.0
1 story	1.10 to 1.20	8.5 to 10.0

This analysis assumes that materials can be delivered at the site on cars, and that form lumber can be used twice. As two-thirds of the total cost is for labor and forms, and one-third for the forms alone, it is economical, where time will permit, to use forms more than twice, or as often as the lumber will last. Repetition and duplication of forms are in fact the greatest factors in cost reduction, and the design should be so made that this is possible. The average cost of forms obtained from a different set of records from those given above, is, for floors with beams, girders and slabs, 10 cents per square foot, and for slab floor without beams 7 cents per square foot. The corresponding cost of column forms is 13 cents per square foot. The cost of bending and placing reinforcing steel, including wire mesh in slabs, varies from \$5 to \$17 per ton, the average being about \$10 per ton.

A reinforced-concrete building designed by the writer, 55 feet wide and 88 feet long, with seven stories

These prices do not include partitions, plumbing, heating, lighting or elevators. In the Southern States or in country districts where labor is cheaper, the unit costs may occasionally be 10 to 15 per cent less. But when buildings are erected by contractors who are only occasionally employed on such work, the cost is likely to exceed the minimum prices given above, and amount to \$1.30 per square foot for buildings of three stories or more, to \$1.60 per square foot for those with only single stories. Concrete framing, including slabs, beams and columns only, without walls, costs from 45 to 65 cents per square foot of floor area.

The cost of reinforced-concrete buildings from numerous designs varies from 6 to 12 cents per cubic foot for factories and warehouses, and from 10 to 16 cents per cubic foot for stores and loft buildings. These are based upon the use of complete concrete frames and exterior curtain walls, without power, heat, light, elevators or interior finish.

Buildings with concrete slabs and 2-inch cement finish, costing \$1.25 per square foot, would with cement finish on 2-inch cinder concrete cost about \$1.30 per square foot, and \$1.35 per foot with $\frac{7}{8}$ -inch maple on 2-inch cinder concrete, with a concrete floor slab in each case.

A two-story reinforced-concrete factory building 100 feet square, at

resent one half of the total cost per cubic yard of the materials in place. The labor of mixing and placing the concrete and of placing the steel will add one-third to the above sum, and the material and labor on forms will be two-thirds more. The resulting cost does not include contractors' profit or plant depreciation. General expense and cleaning up after com-



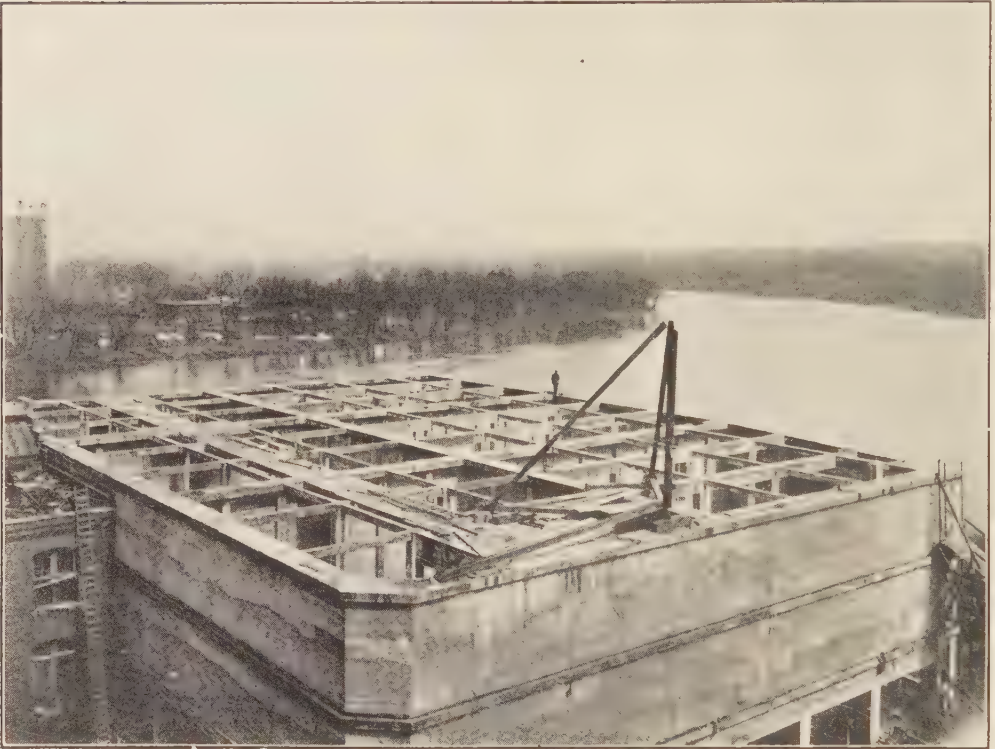
80-FOOT REINFORCED-CONCRETE GIRDERS, HOOD RUBBER CO. WAREHOUSE
Aberthaw Construction Co.

Walkerville, Ontario, with 6-inch curtain walls, and columns 16 feet apart in both directions, cost complete, including concrete, rods, and forms, \$19.88 per cubic yard of concrete in place.

Some contractors used the following method of estimating the cost per cubic yard of all the material in place. First find the cost delivered at the site, of the cement, sand and stone required for a cubic yard of concrete, and to this add \$5 per yard for the reinforcing metal. The sum of these two costs is assumed to rep-

pletion may be \$1 to \$2 per cubic yard additional.

A considerable saving in the cost of reinforced-concrete buildings can be effected by omitting the floor slabs, and using a frame of columns and girders only, with a double course of boards supported on reinforced-concrete beams. For specific example, a four-story office building of this kind at Fore River, Mass., a large part of the curtain walls being glass, cost with the foundations, walls, roof, and floors, only 63 cents per square foot of floor area, or $4\frac{1}{2}$ cents per cubic



A 10,000-TON REINFORCED-CONCRETE COAL POCKET, PACIFIC MILLS PRINT WORKS, LAWRENCE, MASS.
Architects and engineers, Lockwood, Greene & Co. Contractors, Aberthaw Construction Co.

foot of contents. Including lighting, heating, toilets, and partitions, the cost was \$1.30 per square foot of floor, or 9.2 cents per cubic foot. Another similar five-story building in the same state, 50 by 300, cost only 7.6 cents per cubic foot.

Economy often results, also, from the use of separately moulded floor members, a good example being the cold-storage warehouse at Syracuse, recently constructed. The building was six stories high and 78 feet square, and concrete floors of the Watson system were supported by a frame of steel beams and columns. The floors alone cost 20.5 cents per square foot, and the steel frame and fireproofing 21.5 cents additional, or a total of 42 cents per square foot of floor area, or 4 cents per cubic foot of volume for both floor and frame.

Including the gravel roof, curtain walls, and stairs, the cost was 61 cents per square foot, or 5.7 cents per cubic foot, the granolithic floor finish, and wall plastering not being included. In determining these unit prices, the area of six floors and basement was taken inside of the exterior walls.

Much of the published information in reference to the cost of concrete work is based upon the records of well organized building companies who are equipped to do such work in the most economical manner. Other builders with less facilities should therefore be liberal in their estimates. Some contractors when estimating use a cost unit for reinforced concrete of \$1 per cubic foot, or \$27 per cubic yard, for all material in place, which is no doubt large enough for even in-

experienced builders. A fuller discussion of costs will be given in following articles on reinforced-concrete floors.

Where wooden buildings are referred to in the following comparisons, only mill construction of the slow-burning type is considered, for near-



INTERIOR VIEWS OF THE JOHN DEERE PLOW COMPANY'S BUILDING, OMAHA, NEB.

The upper view shows the excellent light distribution. The lower shows the test loading of the floors.

Under a load of 550 lb. per sq. ft., a panel 18 ft. 9 in. square showed a deflection of $\frac{3}{8}$ in. "Mushroom System" of construction; C. A. P. Turner, C.E.

ly all modern industrial enterprises are housed in buildings that are to some extent fireproof. The question may reasonably be asked here, what constitutes a fireproof building? Nothing is more fireproof than a furnace, and yet the decomposition of its contents by fire is its chief use. These buildings must therefore not only be made of non-inflammable material but they must be so arranged that fire when started can be confined to one room or to the smallest possible space. With this object in view, they should be equipped with self-closing metal doors, and windows with wire glass or metal shutters. They should have automatic fire alarms, and above all an adequate sprinkler system. Steel framing must be enclosed and protected with some material such as brick, tile, terra cotta or concrete. Under these conditions, with insurance on the contents, a manufacturing enterprise is reasonably safe.

Building types arranged in order of their relative first cost are as follows:

A. Complete steel frame, fireproofed, with curtain walls and plank floor.

B. Interior steel frame, fireproofed, with solid brick walls and plank floor.

C. Complete steel frame fireproofed, with curtain walls and reinforced-concrete floors.

D. Interior steel frame fireproofed, with solid brick walls and reinforced-concrete floors.

E. Entire reinforced-concrete building.

F. Part interior steel frame not fireproofed, with solid brick walls and wood mill floors.

G. Entire wood mill construction.

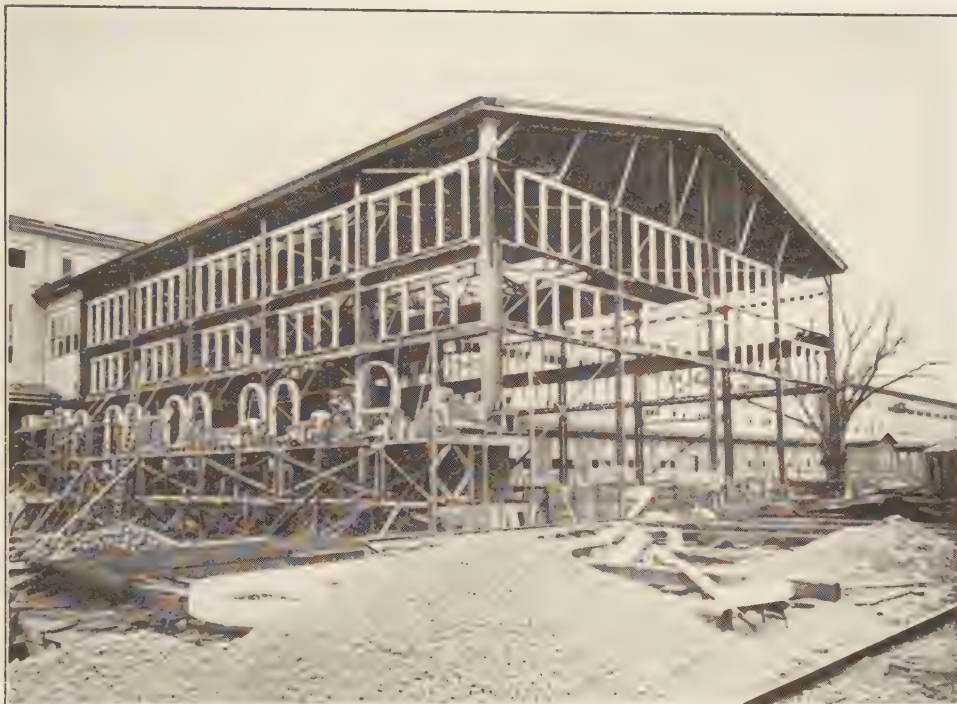
The first cost, however, is not always the governing consideration,

for in these times of large enterprises, any reasonable investment is permissible which will result in ultimate economy, when the expense of maintenance, depreciation, interest and insurance are considered. The selection of a building type is, indeed, a choice of the most profitable investment.

The annual depreciation of wood mill buildings is usually assumed at 1 to 1½ per cent of their first cost, and the corresponding depreciation of concrete buildings would probably not exceed ½ of 1 per cent, though on this subject there is little reliable information as the type is comparatively new. Oscillation and vibration in building frames of wood and steel cause a further loss in machinery repairs and increased power, which is variously estimated at ½ to 1 per cent of the first cost, and this loss is avoided by the use of rigid framing such as concrete. Fireproof types have a slight advantage also over wood construction in the matter of sanitation and light, for more wall area is available for windows, and rats, mice and other vermin have less chance to collect and live.

In comparing the first cost of buildings in wood mill construction and in reinforced concrete, it will be found that their relative cost varies with the location, size of building, and the floor loads to be sustained. In the Southern States, or other regions where timber is abundant and cheap, wood construction will often cost 25 to 30 per cent less than reinforced concrete, while in districts where wood is scarce, the two types may be nearly equal.

The comparison depends also on the size of the building, for large ones have often been found to cost about the same in either material, and small ones are sometimes more expensive



SHOPS OF THE PENNSYLVANIA STEEL CO., STEELTON, PA., ERECTED BY THEMSELVES
 Steel frames throughout. Main floor $2\frac{1}{2}$ in. maple on 4 by 6 sills set in broken limestone. In some parts (assembly, and around certain machines) floor is concrete. Curtain walls 9 in. brick for 20 ft.; above that, 2 in. cement and sand built out on a scratch coat over expanded metal and small channels



FERROINCLAVE FLOOR CONSTRUCTION

Above, laying Ferroinclave sheets, Mineral Point Zinc Co.; below, Ferroinclave flat floor, Superior Foundry Co. Building of steel-frame construction with brick curtain walls and reinforced-concrete floors. The Brown Hoisting Machinery Co.



EXTERIOR OF THE DODGE BROTHERS CO. PLANT, DETROIT, AND INTERIOR OF ONE OF THE MAIN BUILDINGS (MACHINE SHOP)

Kahn system of reinforced concrete and United Steel Sash throughout. Kahn flat ceiling, "Trussed-Con" pressed steel slotted inserts in ceiling for attaching shafting, etc. Trussed Concrete Steel Co.

by 30 to 40 or 50 per cent in reinforced concrete than in wood. The required floor capacity also affects the comparison. Light loads with long spans are cheaper in wood mill construction than in reinforced concrete, the cost of the two types being nearly equal in large buildings with 200 pounds imposed loads per square foot, and column spacing of 18 to 20 feet. With loads of 300 to 500 pounds per square foot, concrete becomes the cheaper, and the saving increases rapidly with greater loads of 1,000 to 1,200 pounds per square foot.

A concrete building designed by the writer and containing about 500,000 cubic feet, was found to cost 17 per cent more than one in wood mill construction, and about the same as a building with complete interior fire-

proofed steel frame, solid walls, and wood floors. It was in Ohio.

As a general rule, therefore, it will be found that reinforced concrete in the Northern States costs about the same as wood for large buildings with heavy loads, worth \$250,000 or more. Those worth \$25,000 to \$100,000 will usually cost 10 to 20 per cent more in concrete than in wood, and small structures, especially for light loads, may be cheaper in wood by 30 to 40 or even 50 per cent.

The following table gives a miscellaneous lot of bids and estimates on manufacturing buildings, with comparative costs in wood mill construction and in reinforced concrete. It will be seen that the costs in most cases are from 1 to 27 per cent higher in concrete than in wood.

COMPARATIVE COST OF WOOD MILL CONSTRUCTION AND REINFORCED-CONCRETE BUILDINGS. COMPILED BY J. P. H. PERRY.

Kind and Place	Size	Stories	Load lb.	Cost of Wood Bld.	Cost of Concrete Bld.	Concrete % more or less than wood	Bid or Est.
Factory, Detroit .....	.....	3	300	\$28,000	\$28,500	1.5 more	Bid
" Jersey City	60 by 140	5	200	52,000	56,000	7.1 more	Bid
" Grand Rapids .....	.....	..	...	85,300	86,000	1.3 more	Bid
" Fall River	112 by 112	4	...	74,000	82,500	10.3 more	Bid
" Manchester	45 by 100	5	...	52,000	72,000	27.7 more	Est.
Warehouse, Boston	20 by 155	9	...	212,500	196,000	6.3 less	Bid
" Jersey City	38 by 94	6	200	39,000	43,000	9.3 more	Bid
" Pittsburg	100 by 120	4	...	61,500	63,600	3.3 more	Bid
" Nashua	100 by 200	8	...	117,000	131,000	10.7 more	Bid
Press Bld., Cincinnati .....	.....	..	...	.....	.....	4.0 more	Bid
Bakery, Cincinnati	60,000 s. f.	..	300	64,000	62,500	2.3 less	Bid
Shop, Cincinnati .....	.....	..	...	16,000	19,100	16.2 more	Est.
" New England .....	.....	..	...	65,800	69,500	5.2 more	Est.

Comparing now the *ultimate* cost of the two types. For convenience, a wooden building will be assumed at \$100,000, and a concrete building 10

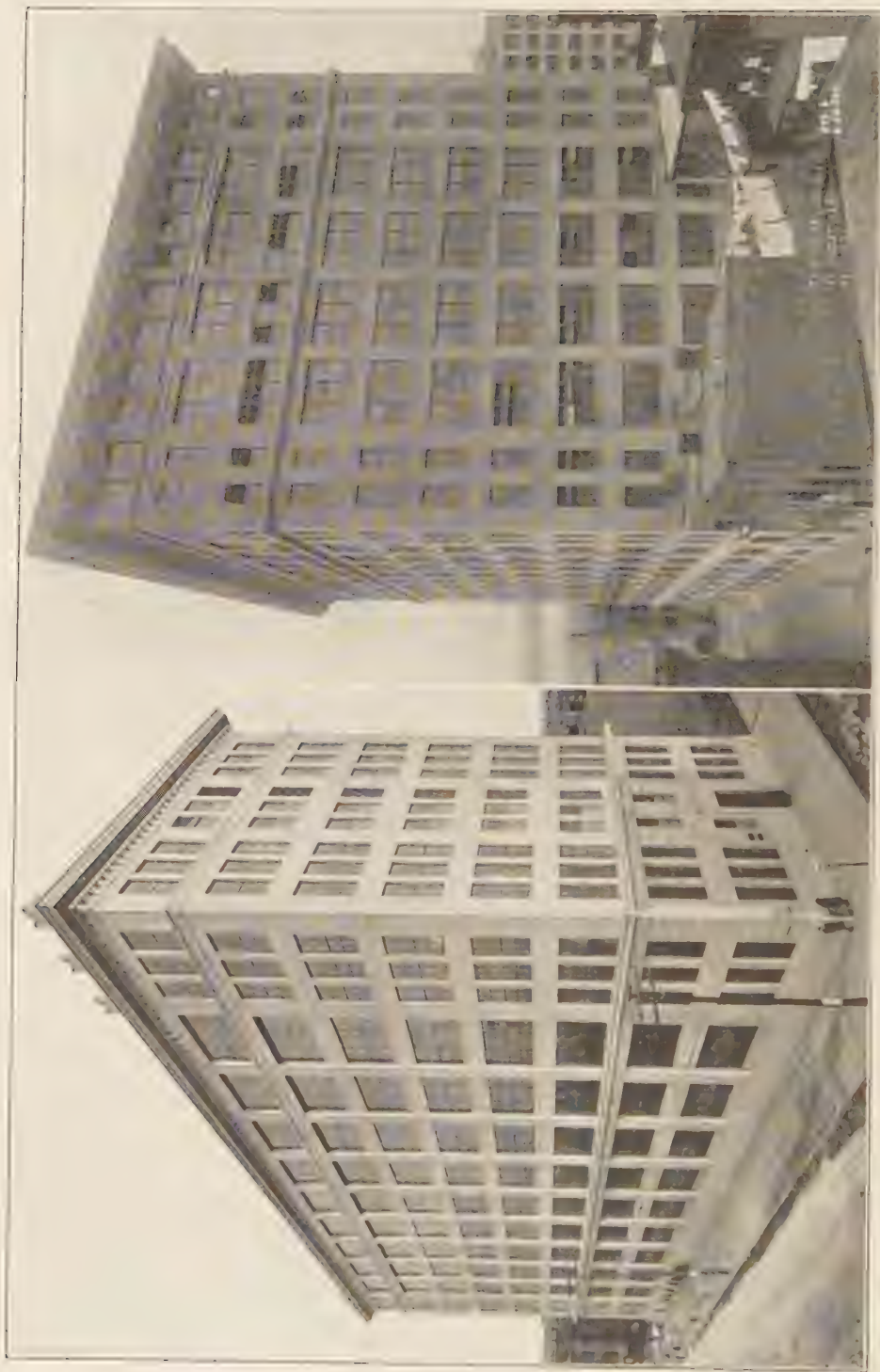
per cent more, or \$110,000, and the contents in each case will be assumed of equal value to the building. The yearly maintenance costs will be:

	Wood	Reinforced Concrete
Depreciation	at 1½ per cent \$1,500	at ½ per cent \$500
Insurance on building	at 80 cents 800	at 20 cents 220
Insurance on contents	at 110 cents 1,100	at 80 cents 880
Interest and taxes	at 7 per cent 7,000	7,700
Oscillation, vibration	at 1 per cent 1,000	0000
Total	\$11,400	\$9,300



INDUSTRIAL BUILDINGS ON THE MUSHROOM SYSTEM OF CONSTRUCTION

Above, International Harvester Co.'s building, Fort William, Ontario; J. & J. A. Elliot Co., contractors, W. G. Uffendell, architect. Below, warehouse of John Deere Plow Co., Omaha; 8 stories, 135 by 285 ft.; Leonard Construction Co., contractors, Fisher and Lawrie, architects. C. A. P. Turner.



ON THE LEFT, THE TURNER-CARTER SHOE FACTORY. ON THE RIGHT, PAPER
The shoe factory is 200 by 60, eight stories, 150 lb. floor loads, granolithic finish throughout. Large light area obtained by use of rolled-steel sash. Frank I.
113 by 176, twelve stories, 200-lb. floor loads, granite finish. Standard Ice Manufacturing Building
metal windows all around. Built by Turner Construction Co.

BOTH BROOKLYN, N. Y.



DETAIL OF EXTERIOR OF MASSACHUSETTS COTTON MILLS REINFORCED CONCRETE WITH BRICK PANELS
Aberthaw Construction Co.

The reinforced-concrete building costing \$110,000 will then have a maintenance cost of \$2,100 per year, or 2.1 per cent less than the wooden one at \$100,000, and this difference of \$2,100 at 6 per cent, is interest on \$35,000. It will therefore be permissible to invest an additional \$35,000

on a concrete building, to make the two types of equal ultimate cost. A concrete building costing \$145,000, or 45 per cent more, has therefore no greater ultimate cost than a wooden one at \$100,000.

In comparing the cost of fire-proofed-steel construction with rein-



INTERIOR OF PLANT OF THE PIERCE-ARROW MOTOR-CAR CO., BUFFALO, N. Y.
 The upper shows a reinforced-concrete saw-tooth roof. Aberthaw Construction Co.



FIGURE 11 SKELETON-STEEL CONSTRUCTION

Steel frame fireproofed; stone or brick curtain walls, fireproof floors. Riter & Conley Mfg. Co.



RECENT INDUSTRIAL BUILDING OF REINFORCED CONCRETE

Above, two shoe factory buildings, 50 by 330, eight stories and basement, Haverhill, Mass. Below, building under construction for the East Boston Co., showing the unit system as distinguished from the monolithic type. Concrete Engineering Co.

forced-concrete, complete framing and exterior curtain walls being considered in both cases, it will be found that for imposed floor loads of 150 pounds per square foot or more, concrete will be cheaper than steel by 5 to 20 per cent, depending on conditions. For light loads, the cost of the two types will be nearly equal, and in some cases with very light load and long spans, steel framing will be slightly cheaper. One-story buildings

over large areas are best when framed in steel.

A comparison made by the writer, on a building costing about \$50,000, for total floor loads of 200 pounds per square foot, showed that one with fireproofed-steel framing and heavy wooden floor cost 12 per cent more than one of reinforced concrete with granolithic floor surface. It appears, therefore, that factory buildings of reinforced concrete have the lowest

cost of any fireproof construction that is yet available.

The following table gives the comparative cost of a variety of buildings of different kinds, in both reinforced concrete and in steel. It shows that the former type is cheaper than the latter by 3 to 13 per cent.

proofed-steel frame, side curtain walls and wood floors, costs 30 per cent more than wood mill construction, while the same building with only interior fireproofed-steel frame and solid bearing walls cost 19 per cent more than wood. If the first building mentioned above had a rein-

COMPARATIVE COST OF BUILDINGS IN REINFORCED CONCRETE AND IN STEEL

Kind	Place	Size, feet	Stories	Load, lb.	Cost of Reinforced Concrete	Cost of Steel	Re-Con. more or less than steel, per cent	Bid or Est.
Factory	Des Moines	66 by 132	6	200	\$60,650	\$69,750	13.0 less	Est.
Factory	Fairmount	50 by 100	3	200	25,000	28,000	10.7 less	Bid
Warehouse	Brooklyn	140 by 190	10	200	250,000	280,000	10.7 less	Bid
Office	St. Louis	86 by 120	8	70	170,000	184,000	7.6 less	Bid
Office	Cincinnati	.....	17	70	.....	.....	4.0 less	Bid
Mill	Boston	.....	3	...	278,200	286,400	2.8 less	Bid
	Cambridge	60 by 320	5	...	90,000	87,300	3.3 more	Bid
Store	Indianapolis	71 by 120	6	125	89,500	96,000	6.8 less	Bid
Hospital	Indianapolis	.....	6	...	793,000	823,000	3.6 less	Bid
Hotel	St. Louis	120 by 140	8	70	171,000	184,000	7.0 less	Bid
Hotel	St. Louis	.....	11	70	290,000	304,000	4.6 less	Bid
Factory	Ohio	.....	12	200	40,000	less than steel		Bid
Loft	Springfield	105 by 283	9	150	280,000	320,000	12.5 less	Bid

From comparative estimates made by the writer for a building of 500,000 cubic feet, to determine the comparative cost of fireproofed-steel construction and wood mill framing, it appears that one with complete fire-

forced-concrete floor, its cost would be 37 per cent more than wood mill construction, while the corresponding cost of the second one with reinforced concrete floor would be 26 per cent more.

PRACTICAL FIRE PREVENTION

By Edward F. Croker

It is not generally realized by laymen that order, cleanliness, discipline, alert administration and inspection are even more effective in fire prevention than mere occupancy of fireproof structures. This aspect of wholly practicable protection is developed by ex-Chief Croker in the following pages.—THE EDITORS.

A SERIES of fires, culminating in a holocaust in Newark, N. J., and quickly followed by the disastrous fire in the Asch building in 1911, brought to the minds of the public the startling fact that insurance to cover loss by fire was not a complete panacea for the many dan-

gers and loss of life occasioned by that most dreaded enemy of civilization—fire. It was then that the Legislature of the Empire State became alive to the situation, and in quick succession followed laws creating a State Fire Marshal, a new bureau for the prevention of fires for the City

of New York, and the appointment of a splendid non-partisan body of public-spirited citizens known as the State Factory Investigating Commission. Thus, a quiet but persistent agitation, beginning as far back as 1835 and continually kept alive by various people (prominent among whom was the late Edward Atkinson) for practical fire prevention has borne fruit.

When in 1899 I was appointed Chief of Department, the consolidation of the various boroughs had recently taken place and the welding together of the various elements into a single department was in itself a sufficiently difficult problem to keep everyone connected with the department exceedingly busy. This having been accomplished, however, in 1904 the department began in a modest way to make a study of the subject of fire prevention, and the formation of a subordinate branch, under the direction of the Chief of Department, known as the Bureau of Violations, began to impress upon the people of New York that the department required their co-operation and assistance by the installation of various auxiliary fire appliances, such as standpipes, hose, fire extinguishers, sprinkler and automatic fire-alarm systems, etc., to keep in check and promptly subdue fires in their incipient stage, pending the arrival of the department. This was not such an easy task as might be imagined; property owners began to protest against the additional expense imposed upon them, and the department was compelled (through the assistance of the Corporation Counsel, in charge of the Bureau for Recovery of Penalties) to fight step by step for the enforcement of its demands, which were entirely reasonable and valid, but too often looked upon by the business public (not alive to the necessity of practical fire-prevention) as an unnecessary hardship.

EVOLUTION OF FIRE PREVENTION

Fire prevention is simply the science of making life and property safe against destruction by fire. It should always be remembered that all fires are small at the beginning, and most are due to preventable causes, such as gas, rats' nests made of matches and oil-soaked cotton, poor electric wiring, spontaneous combustion, accumulation of rubbish, etc., all of which can be eliminated by a system of careful and practical inspections. While our fire departments are as a rule splendidly organized and thoroughly equipped with the most approved apparatus and the members ever ready to lay down their lives in the performance of their duty, it must be remembered that fire spreads with the rapidity of lightning, and very often when the department is summoned, especially upon a delayed alarm, they can do nothing more than confine the fire to the building in which it originates. Here is where the great value of the installation of the "quick-acting" automatic fire alarm, the automatic sprinkler, the fire-proof door, standpipes, hose, fire extinguishers, fire hooks, axes, etc., and the drilling and instructing of the employees should be recognized, for with such organization and appliances, nine out of ten fires can be held in check until the arrival of the department and thousands of dollars saved to building and contents.

"An ounce of prevention is worth a pound of cure," with fires, as well as any other evil; but the average business man heretofore has not acted upon this principle, relying rather on the assurance of his insurance broker that he is protected against financial loss. Because he is a taxpayer and voter, he calmly depends upon the fire department to come and put out his fire, not realizing the natural limitations to the most efficient of all fire

departments. Most fires can be prevented, and those that cannot, can be discovered and extinguished with very little loss or danger. In this connection the fire expert becomes a necessity to the average man and woman. *He should, however, be an expert*, well informed about the causes of fires and how to remove them—one who understands the planning and construction of buildings and hence is able to consult with architects and builders, one who possesses also a thorough knowledge of the many approved detecting and extinguishing appliances, and who appreciates what firemen need as an assistance in putting out fires. This is where a new field of professional activity has appeared. This is why organized, expert advice and instruction, and systematic inspection and service have become a factor in the science of the prevention of fire.

FUNDAMENTAL PRINCIPLES OF FIRE- PREVENTIVE SERVICE

An inspector should make a study of the building, apply the principles of fire prevention to existing conditions, and in his report furnish proper recommendations for rendering the premises safe. Its external conditions must be considered, to see what dangers it faces from its neighbors and the buildings in the vicinity. To meet this outside exposure, wire-glass windows or iron shutters are recommended. The roof must also be examined and the skylight protected against fire-brands dropping through the glass and causing fire within. In the interior of the building the hazards must be examined and dangerous conditions corrected. These are often found to exist in the heating and lighting fixtures, unnecessary rubbish, and storing of unused and unnecessary articles. These matters always require special attention, and with the building generally in a

clean condition, causes for fires can generally be removed. It is advisable that all stairways, elevators and other openings through the floors be enclosed, thus preventing fire from spreading through them from one floor to another.

The next step should be to determine and procure proper and suitable fire extinguishers and detecting appliances, (including the service of competent retired firemen to act as watchmen) such as automatic fire alarms, sprinklers where necessary, bell systems for drills, etc., a manual box to notify fire headquarters, safety bucket tanks containing fire pails, fire extinguishers, standpipes and hose on each floor in certain classes of buildings, fire stops, such as fire doors (self-closing) fire windows or windows with wire glass, and in buildings of large areas, fire walls.

Then comes the provision and conduct of fire drills, which are absolutely necessary in almost all classes of buildings, and with these should be given frequent short lectures as to the proper method of acting in case of fire or other alarm, and how to use fire appliances properly; emphasis should be laid upon the necessity of keeping premises in a clean condition, throwing oily waste, rags, paper, rubbish, etc., only into self-closing waste cans; having sufficient aisle space, etc.; the formation of employees into ranks and their quietly marching under leadership to exits, the assignment of certain employees to use fire appliances, notification of the fire department, and co-operation with the firemen when they arrive. This fire drill should be installed by no one but a fire expert, because it is only the expert who can anticipate the starting of a fire, indicate its probable extension, and provide for the unusual conditions that are bound to arise. So called fire drills given by amateurs, with little knowledge or

skill, are as bad as if not worse than no fire drills at all.

Then must follow a system of weekly, semi-monthly, and monthly inspections of buildings, which must be thorough and searching in their operation, and any change in conditions previously noted should be immediately communicated to the owner or tenant with proper recommendations to meet each individual case.

In buildings where resident expert inspectors (desirably retired firemen) are stationed permanently, visits should be made at frequent and irregular intervals by supervising inspectors, who ascertain if the men are properly performing their duties to which they have been assigned.

Long experience in the fire department has shown me that if such methods of inspections, drills, reports and recommendation were put into general practice by the various factories, lofts and business buildings, hotels, institutions, etc., their premises would be as safeguarded from the possibility of fire occurring as it would be possible to make them, and the number of fires and the fire loss would be so greatly reduced as to cause the business men to ponder why they had not obtained such a service long ago, particularly as the cost is reasonable and the results highly satisfactory.

FIRE-PREVENTION PRINCIPLES CARRIED INTO PRACTICE

The practical working of these principles under city conditions is perhaps permissibly illustrated by methods of preventing fire and the resultant loss of property and life as worked by me after retirement from the New York Fire Department. They embody the results of twenty-seven years' experience in all ranks from fireman to Chief of Department. They are based on the principle of directing all available energy to the prevention rather than the fighting

of fire. The organization employs only retired members of the Fire Department, of good record, uniformed, for influence not only upon the force, but upon the public.

Its service and advice in any individual case begin with the work of the inspection branch. Inspection reports not infrequently show that manufacturing or business premises are about as safe as if there were a keg of powder with a careless boy smoking a cigarette in close proximity. Among the conditions found are accumulations of rubbish, lack of passage ways, doors opening inward and locked, smoking going on continuously, with highly inflammable material nearby; floors without a single bucket of water or fire extinguisher to extinguish an incipient blaze, defective insulation, poor electric wiring, defective rubber gas tubes, etc., and hundreds of employees of both sexes, old and young, who at the sound of the word "fire" (let alone the sight of a blaze) would immediately be thrown into a panic and act with as much reason as a flock of frightened sheep. These were the rule.

Upon the receipt of these reports, carefully looked into and examined, the advisory department comes into action and recommendation after recommendation is laid before the subscribers. Some, and I am glad to say, only a small number, consider chiefly the expense involved in complying with the recommendations. Most men, however, yield to consideration of the moral hazard involved, and their personal responsibility in case of fire. They realize also the fact that with thousands of dollars invested in their business, an expenditure of less than 1 per cent of that investment will not only prevent a stoppage of business with all the attendant loss, but will avert possible loss of life and injury to employees.

After reducing as far as possible and in some cases eliminating entirely various existing hazards, the inspectors begin to organize the employees into fire brigades, establishing small fire companies from among the various employees on each floor, instructing them what to do and particularly *what not to do* in case of fire; showing them how to handle various fire appliances properly, and instructing them how to act on receipt of the fire signal when transmitted on the interior fire-alarm or bell system. The interest showed by the employees (in many cases foreigners, unable to understand our language) is remarkable, and they prove apt scholars. Were a fire or even an explosion to occur today in one of these premises, a well organized and trained corps of men and women would move rapidly, but without panic, to a place of safety, and other of the employees, regularly assigned for the purpose, would immediately seize and intelligently handle various auxiliary fire appliances upon the seat of the fire. The alarm for fire would be immediately telephoned or sent from the nearest street box to Fire Headquarters, and the success achieved would compensate a thousandfold the slight expenditure involved for the appliances installed and the cost of the service.

In other cases, such as hotels, department stores, theatres, banks and insurance buildings, the method adopted is to place retired members of the Fire Department, in uniform, and under systematic supervision, permanently in the premises, on duty continuously during working hours. These men drill the employees daily, inspect the premises at all hours, and are always on the alert looking after the safety of the employees and the building. During the Christmas holidays and on Saturdays hundreds of

thousands of people are continually frequenting department stores, theatres, etc., and these men are ready at an instant's notice to forestall and prevent any panic or other danger.

Another prominent feature of such an organization is the inspections of isolated factory plants outside of the protection zone of a regular fire department, and here the system of organization of employees into fire brigades, fire drills, and semi-monthly or monthly inspections of these plants, with written reports and recommendations, has reduced to a minimum and in many cases eliminated entirely very dangerous existing fire hazards.

A further extension of the idea has been of considerable service to village fire departments, mostly manned by volunteers, endowed with lots of enthusiasm and very zealous in their efforts to protect property in case of fire, but without practical experience and more especially without efficient apparatus to extinguish fire promptly. In such cases the service of practical and experienced retired officers of the New York Fire Department are supplied to give such volunteer departments a complete course in every branch of the fire service.

Various architects and builders have not hesitated to avail themselves of the benefits of these many years of systematized experience with fire in buildings of various materials and methods of construction, and obtaining thence ideas as to the best means of preventing or checking the spread of fire in buildings in contemplation or about to be rebuilt. In this way the fullest measure of safety may be secured, for fire-resisting qualities are incorporated into the very form and substance of the plant itself, and to these all the principles of fire-preventive management, discipline, auxiliaries and service may be added.

THE GIST OF THE PROPOSED PATENT-LAW AMENDMENTS

By Gilbert H. Montague, of the New York Bar

"In the world's history certain inventions and discoveries occurred of peculiar value, on account of their great efficiency in facilitating all other inventions and discoveries. Of these were the art of writing and of printing, the discovery of America, and the introduction of patent laws. . . . The patent system . . . added the fuel of interest to the fire genius, in the discovery and production of new and useful things."

THESE are the words with which Abraham Lincoln, in a speech at Springfield, Illinois, in February, 1860, described the patent system. The American patent system, in its essentials, is the same now as then.

The English patent law, the only one developed before ours, was intended to reward men who brought into England from a foreign land some new industry or improvement. Primarily, it did not reward inventive thought.

The framers of the Constitution of the United States, however, followed the tendency of several of the American Colonies, and laid stress entirely upon the reward of inventive thought. With a unanimity of action remarkable in the Federal Convention, they empowered Congress "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries." They knew that "the encouragement of new inventions and discoveries," as Alexander Hamilton in 1790, explained in his masterly Report on Manufactures, is among the most useful and unexceptionable of the aids which can be given to manufactures;" and that if inventive thought were recognized and rewarded "by securing, for limited times, to authors and inventors, the exclusive right to their re-

spective writings and discoveries," the result would certainly be "to promote the progress of science and useful arts." They adopted the theory, original with themselves, that if, by the certainty of reward, they encouraged men to invent—if, as Lincoln put it, "they added the fuel of interest to the fire of genius, in the discovery and production of new and useful things"—then industries and manufactures, as Alexander Hamilton prophesied, would take care of themselves.

In 1876, the foreign commissioners attending the Centennial Exhibition advised their governments that American superiority, in respect to machinery and mechanical tools, was due to the American patent system. What most impressed them, judging from their reports, was the stimulus to invention which the patent law afforded to every mechanic working in every factory and workshop throughout the country. The Committee of the United States Senate on Patents, in 1878, clearly discerned this to be the most important feature of the American patent system, and stated in its report:

The protection which the patent system gives a patent owner in the results attained induces him, *and is all that will induce him*, to expend the time and money—often several hundred thousand dollars upon a single

machine—in perfecting the invention, embodying in it a practically useful machine, and introducing it to public use. The Committee are, therefore, convinced that the framers of the Constitution were wise in their judgment, when, in entrusting to Congress “the power to promote science and useful arts,” they gave them only one means for doing it, namely, “securing, for limited times, to authors and inventors the exclusive right to their respective writings and discoveries.” *No change should be made in the patent law to weaken the inducement*, which, in its ordinary and normal operation in the common transaction of business, it offers to those who will successfully invent, and to those who, by persevering and expenditure, will perfect inventions and the machines in which they are embodied, and push their introduction so as to put the public in possession of perfectly working machines or a perfectly finished product.

The principles that actuated the Federal Convention in framing the Constitution, and Alexander Hamilton in his recommendations in his Report on Manufactures, and the first American Congress and President George Washington in the enactment of the first patent law, and four succeeding generations of American statesmen, who have unstintedly attributed the unexampled national and industrial development of the United States to the American patent system, must be the standards by which to judge the present proposals to amend the patent law.

SOME PROPOSED PATENT-LAW AMENDMENTS

For several months, bills to amend the patent law have been pending in Congress. Many relate to patent practice. Some relate to the internal organization of the Patent Office. The importance of such bills must

not be minimized, for the details to which they are directed may make or mar the successful operation of the patent system. Other bills, however, directly affecting the essentials of the present patent system, overshadow in importance all other proposals. For lack of space, the only measures that can here be discussed are a few that have attracted wide attention because of the seriousness with which they have been urged, and of their tremendous consequence upon the patent system. These are proposals for so-called “compulsory licenses,” and proposals for prohibiting so-called “license restrictions.”

Several bills propose to enable anybody, during the life of a patent, to apply to the Commissioner of Patents for a license to make, construct, use, and sell the patent article, and to compel the patent owner to grant a license to any applicant, upon such terms and for such royalty as the Commissioner “deems just.” Even though one or more licenses have previously been granted, the patent owner must, nevertheless, grant a license to anybody who thereafter applies for one.

Several bills provide that unless the patent is worked within four years after it is issued, or “unless the owner shall show sufficient cause for such inaction,” the patent owner must grant to any applicant a license to use the patent invention; and in the event of the refusal of the patent owner so to do, the District Court shall hear the applicant, and if satisfied that “the reasonable requirements of the public in reference to the intention have not been satisfied,” the court shall compel the patent owner to grant a license to the applicant upon such terms and for such royalty as the court “deems just.” These bills also provide that at any time during the life of a patent,

whenever "a material and substantial improvement shall be patented, the manufacture of which would be an infringement on the original patent," the owner of an improvement may, upon application to the court, compel, in like fashion, the owner of the original patent to grant a license to enable such improvement to be manufactured.

These bills, in one form or another, all provide for so-called "compulsory licenses."

Several bills provide that anybody that purchases or obtains a license to use an article embodying a patented invention shall have an absolutely "unrestricted right"—regardless of any qualifying agreement made by such purchaser or licensor with the patent owner—to use, sell, or lease the article so purchased, without any liability whatsoever for any infringement of the patent or the license.

Several bills, affecting articles patented and unpatented, forbid any agreement between seller and purchaser, licensor and licensee, lessor and lessee, or bailor and bailee (1) restraining such purchaser, licensee, lessee and bailee from obtaining any article from any other person; or (2) imposing any restriction upon the use of the article so sold, licensed, leased or bailed; or (3) making any discrimination in the price, rental or license based upon whether the purchaser, licensee, lessee or bailee uses such articles furnished by some other person, or any discrimination based upon whether the purchaser, licensee, lessee or bailee takes articles of a particular quantity or aggregate price; or (4) restraining such seller, licensor, lessor or bailee from disposing of an article to any specified persons, or to persons doing business within specified districts or territories.

These bills, in one form or another,

all prohibit every kind of so-called "license restrictions."

How do these various bills affect the "inducement" to invention,—the "fuel of interest," in Lincoln's phrase, "to the fire of genius in the discovery and production of new and useful things"?

COMPULSORY LICENSES VIOLATE FUNDAMENTAL PROPERTY RIGHTS

The patent owner's "exclusive right," conferred upon him by the Federal Constitution and the Revised Statutes, is limited to a period of seventeen years. "For his exclusive enjoyment of it during that time," Chief Justice Marshall stated in a classic opinion, "the public faith is pledged." At the expiration of that time, it entirely ceases, and the public is entitled to the free enjoyment of the invention.

The notion that a patent owner, unlike owners of other forms of property, is a kind of "trustee for the public, that he is under a sort of moral obligation to see that the public acquires the right to the free use of that invention, as soon as is conveniently possible," has been declared, by no less an authority than the United States Supreme Court, to be without foundation in logic, or in the intention of the American patent system. The Court disposed of this notion in downright fashion:

We dissent entirely from the thought thus urged. The inventor is one who has discovered something of value. It is his absolute property. He may withhold the knowledge of it from the public, and he may insist upon all the advantages and benefits which the statute promises to him who disclose to the public his invention.

The court brushed aside "the nice, sharp quillets of the law" and rested

its opinion on plain, every-day, business common sense:

The patent for an invention is not a conveyance of something which the Government owns. It does not convey that which, but for the conveyance, the Government could use and dispose of as it sees fit, and to which no one save the Government has any right or title except for the conveyance. . . . The Government parted with nothing by the patent. It lost no property. Its possessions were not diminished. The patentee, so far as a personal use is concerned, received nothing which he did not have without the patent, and the monopoly which he did receive is only for a few years.

The patent owner, even more than owners of other kinds of property, should be absolutely undisturbed in the use or non-use of his "exclusive right" during the short period of seventeen years that it is his.

Until Congress is prepared to compel owners of unimproved real estate, unoccupied houses, idle horses, or unworn clothing, either themselves to improve real estate, occupy their houses, use their horses, or wear their clothing, or to surrender possession of them to the first applicant, upon such terms and for such rental as some court "deems just," no reason exists why such drastic treatment should be accorded to owners of property in the form of patents.

The public is already better secured as regards patents than in respect to any other form of property. While property owners may in general lawfully suppress the use of their property so long as they desire, and no one for a moment would suggest that such right be curtailed, the patent owner, at most, can suppress his invention only during the life of his patent; and when the statutory period of seventeen years has expired,

the disclosure which he made, in order to obtain his patent, enables the public to enjoy the invention absolutely, without restriction and without price.

COMPULSORY LICENSES DISCOURAGE INVENTION

Today every inventor knows that if he has a new idea amounting to an invention he may, under the Constitution and the existing patent law, obtain the "exclusive right" in that idea, and absolutely own it, as his own property, for a period of seventeen years. Perhaps there is no immediate market for his invention, because the art has not progressed sufficiently. Nevertheless, he can work it out and patent it, in the expectation that during the term of his patent the art will so develop that his invention may become commercially available. If he has insufficient means to go into business on his own account, his patent still gives him seventeen years within which to seek financial help for its exploitation, to sell it, or to find licensees who will work it.

Today every manufacturer knows that if he experiments with new ideas and new things to manufacture, and acquires patents on them, though they be of no immediate commercial utility, they may years hence fit into his industry and during the latter part of the patent term eventually become profitable to him.

Today every capitalist knows that money risked in the exploitation of a patented invention may, notwithstanding the discouragement and expense of the experimental period, bring him a profit during some portion of the period throughout which his patent enables him to control the invention.

What induces inventors, manufacturers and capitalists today to seek new ideas and to exploit them is the certainty that, if a patent is obtained,

the patent owner, for the period of seventeen years, can control his "exclusive right" in the patented invention just as absolutely as owners of other forms of property control their property. Whenever, during those seventeen years, they find a demand for the patented article, they can handle it like the demand for any other piece of property, in the manner most advantageous to the owners.

This "exclusive right" of the patent owner, in all respects is akin to ordinary property rights, except that it endures for only seventeen years; and it "is all that will induce him," as the Committee of the United States Senate on Patents, in 1878, declared, "to expend the time and money—often several hundred thousand dollars, upon a single machine—in perfecting the invention embodying it in a practical useful machine, and introducing it to the public use." In Lincoln's homelier phrase, it is "the fuel of interest to the fire of genius, in the discovery and production of new and useful things."

What effect will these proposals for "compulsory license" have upon present inducement to inventive effort?

The Chairman of the Legislative Committee of the Inventors' Guild, himself an independent inventor, has answered this question:

The only possible effect it may have upon me is to take away from me something I now possess. . . . Suppose I am manufacturing something which is a parent patent. I do not mean a fundamental patent, because, as I have indicated, practically all patents are improvement patents, but it is a broader patent, a pretty broad patent, and I know that and I manufacture it. I am filling the field, doing the work, and I am filling the demand properly. A large corporation in the electrical field comes along

and takes out a subordinate improvement patent along this line. It then alleges that this is a great improvement. Perhaps it is, and perhaps it is not, and it is a question of opinion. I have invested my capital; I am the original inventor so far as this particular art is concerned. They come along with this trivial improvement patent, and they go into court and demand I be put in a position so that I grant them a license under my parent patent and enable them to use that at such royalty as the court may determine. I am wiped out; that is the end of me. They have taken this trivial improvement patent, a newly issued thing. Nobody knows the merits of it and nobody can know the merit of it, because you cannot judge anything of that kind merely from the reading of it. They have good lawyers and give strong arguments and give a lot of evidence to the record, and they finally get from me under my parent patent a license for a small sum; and that is the end of me—my capital that I have invested and the work that I have given; and I continue to get my trivial royalty from them, and probably settle with them on some terms that are the best that I can get. . . .

That practically means this: that you take away from the inventor a monopoly and say to him, 'We will put you not in the position of the monopoly, but on just as good terms as we give the big corporation, and you will compete with the big corporation.'

You do not have any advantage due to the fact that you have invented this thing, then. The best weapon against monopoly that can ever be made is the efficient patent system that will give the small man who has devised something that is a very great improvement—give him such a position that he is going to be able to develop a new line of industry, notwithstanding the fact that the old line has enormous wealth and power.

While a patent owner is using his utmost endeavors to establish the utility of his invention, it is unjust to have him crippled, at the outset, by a system of compulsory licenses that can be taken advantage of by the very people whom the proposed legislation is professedly intended to reach. After he has established the utility of his invention, it is unjust to have it destroyed by compelling him to grant a license to parties who have contributed no expenditure or effort to the invention. How illusory is the proposal for determining the royalty that he shall receive for the license that he is compelled to grant, has been explained by an independent inventor:

Everybody realizes, that is familiar with the past history of the invention, for example, of the wireless telegraph or of the incandescent lamp, or any other important invention—the telephone—that had the terms of royalty been fixed, we will say, the first year of life of that patent, it would almost certainly have been inequitable.

If anybody can compel the patent owner to issue a license, the patent ceases to be his "exclusive right," or even his property at all; and the sole inducement for which inventors, manufacturers and capitalists devise and exploit inventions is absolutely destroyed.

The experience of foreign nations shows that laws designed to compel the working of patents result in unfair advantage to strong manufacturing interests. In practical operation, they have been a constant source of friction and oppression and have been utilized to the great advantage of grasping financiers. In every country where they exist, it should be noted, patents afford broader protection than in the United States, protecting substitute structures as well

as the main one, in a fashion that does not obtain and would not be practicable here. Compulsory licenses, in a country like the United States, would inevitably breed the greatest confusion regarding the rights of co-owners, licensees and territorial grantees.

The nearest approach to these conditions that can be found anywhere in Christendom is in Holland, where, until recently, no patent system existed. In spite of highly developed commerce, abundant capital, and an intelligent and enterprising population, Holland has remained industrially undeveloped and ranks among the least industrial countries of the world. The explanation is given by the President of the American Institute of Chemical Engineers, himself of Flemish origin:

There was no incentive to saddle oneself with all the risks and outlays of starting a new enterprise, or of improving methods of manufacture, knowing beforehand that, in case of success, one's neighbor could simply do the same thing without any restriction whatever.

LICENSE RESTRICTIONS TRAP NOBODY

The clamor against so-called "license restrictions"—that is, agreements between the patent owner and his customers, defining the manner in which the patented article shall be used or disposed of—arises chiefly from a popular misconception of the recent decision of the United States Supreme Court in the Dick patent case.

The eminent fairness and good sense of this decision, in sustaining the validity of license restrictions, appears, when it is recalled that, under the law as laid down in that case, and in innumerable cases that previously had been decided in the same fashion, no license restriction is enforceable unless the restriction

is brought home to the person acquiring the article at the time the article is acquired. To make a license enforceable, the Court expressly said, "the purchaser must have notice that he buys with only a qualified right of use."

The notion engendered by Chief Justice White's dissenting opinion in that case that Henry would have been held as an infringer, if Miss Skou or any other user of the Dick mimeograph had bought Henry's ink at a corner drug store, has absolutely no foundation in fact.

The infringement in the Dick case, the Supreme Court expressly held, consisted in the fact that Henry, knowing of the license restriction, and with the expectation and intention that his ink would be used for the purpose of violating this license restriction—to which Miss Skou, as Henry well knew, had expressly assented when she acquired the mimeograph—had supplied Miss Skou with the means of accomplishing this wrongful act. Indeed, the Court below expressly found that Henry had deliberately and knowingly instigated Miss Skou to this wrongful act, and had even instructed her that if she would pour Henry's ink into Dick's can, and throw away Henry's can, she would not be caught violating the license restriction.

Unless, at the time the patented article is acquired and as part of that very transaction, the patent owner, by express notice, or by a conspicuously affixed label or other communication no less direct and explicit, discloses to the prospective customer, while he is balancing the advantages and disadvantages of acquiring the patented article, just what restrictions are imposed upon its use, and thus affords the prospective customer full opportunity to make his determination with all the elements in

mind, the license restriction is absolutely unenforceable. This is the law to-day. This was the law which the Supreme Court laid down in the Dick case. Since the American patent system was founded, this has always been the law in this country. This is to-day the law in every English-speaking community in the world. As an English judge happily expressed it: "It seems to be common sense, and not to depend upon any patent law or any other particular law."

In a former article it has been explained that the patent owner's "exclusive right" to make, sell and use his patented invention, which is conferred upon him by the Constitution and the patent law, may be separated into its component parts, namely, the "exclusive right" to make, the "exclusive right" to sell, and the "exclusive right" to use; and that the "exclusive right" to use may in turn be divided into fragments—such as the "exclusive right" to use in a specified territory, the "exclusive right" to use in certain specified trades, the "exclusive right" to use with certain specified machines, the "exclusive right" to use with certain specified supplies, and so on. Patent owners, it has been explained, have an interest in the standing, reputation and commercial desirability of their patented articles, and in respect to their use by their customers may insist upon such conditions as shall insure to the customers, and also to the patent owner and to all prospective customers, the standing, reputation, and commercial desirability of the patented article. Accordingly, they may require customers to use the patented article in such manner, and with such supplies, and with such other machines in the sequence of the manufacturing process, as will insure the satisfactory operation, and the completed result for which the article

was devised. In all this, the right of the patent owner is entirely analogous to the familiar right of the real-estate owner, who may sell his house subject to a restriction for residential purposes, or may lease his premises with restrictions against certain businesses or certain uses, to the end that the standing, reputation, and commercial desirability of the premises, and of similar or adjacent property, may be fully assured. In one respect only does the right of the patent owner differ from the rights of owners of other forms of property. Rights in other forms of property continue forever undiminished, while rights in patents perish absolutely after seventeen years.

No argument is needed to justify a license restriction to which the customer's attention is drawn at the time he acquires the article, and to which he voluntarily assents when he acquires it, which merely requires that he use the article only with supplies that are specially prepared for it, or in continuity with machines that are specially adapted to it, or in some particular manner requisite in order to accomplish the purposes for which the article was intended.

"It may be that the article is of such nature that, in order that it shall work properly, it shall require very great care in selecting certain conditions of use, certain materials to be used in connection with it," explained an officer of the Inventors' Guild. "It certainly is a fact that, in some instances, a man's market for a good article would be completely destroyed, if he could not insure himself in seeing that it was properly used after it left his hands."

Instances of delicate machines, each adapted to perform one stage of a manufacturing process, and together constituting an industrial series

precisely adjusted to take the materials through the successive stages of the manufacturing process until the finished result is finally produced, may be found in many highly developed manufacturing industries. In such instances, the greatest wrong would result from a law, like the measures now under discussion, forbidding all license restrictions in respect to supplies, accessory machines or appliances, or the manner of use of the patented machine.

LICENSE RESTRICTIONS ARE NECESSARY IN INTRODUCING NEW IMPROVEMENTS

The suggestion that the self-interest of the user is sufficient guaranty that proper supplies, well adapted accessory machines, and correct methods of operation will always be used does not prove sound in practice. In the case of staple commodities, this rule doubtless obtains. Most patented articles, however, are not in this class. They are new devices in the arts, and depend for their marketability and value upon their demonstrable efficiency. They must make their way in competition with older appliances, and only as they prove their superior efficiency, in producing the results for which they were invented, can they obtain any market and attain any value. When this result depends, in any considerable degree, upon the supplies, the accessory machines, or the method of operation, it frequently is necessary, and always is reasonable, that the patent owner, whose time, effort and capital are staked upon the result, should require of the customer, as a condition of acquiring the machine, that it be used only with such supplies, accessory machines and method of operation as shall insure a satisfactory result. Since every patented article is essentially new, most users must neces-

sarily be more or less unfamiliar with many of the elements involved in its satisfactory operation. Unaware of the reasons why some particular kind of supplies, or some particular accessory machines, or some particular method of operation, is more certain than any other to produce a satisfactory result, most users would succumb to the apparent economy of the superficial attractions of inferior supplies, ill-adapted accessory machines, and less efficient methods of operation. Of course, the result to the user would be unsatisfactory. Continuance of this unsatisfactory condition, if studied and analyzed by the user, might eventually induce him voluntarily to use only those specially prepared supplies, properly adjusted accessory machines, and correct methods of operation, which the patent owner knows to be essential to the satisfactory operation of his machine. Most users, however, have no opportunity for such study, analysis and reflection. Unless the patented article, in whatever fashion it happens to be used, promptly demonstrates its undoubted superiority over older appliances with which it competes, most users will promptly discard it and return to the older appliances. While the user who has improperly used the machine has thus unwittingly acted against his own interests and harmed himself, he has, in immeasurably greater degree, injured the reputation, standard and commercial desirability of the patented machine. The patent owner, who has risked his time, effort and capital in the invention and has staked everything upon its reputation, standard and commercial desirability, is the chief loser.

"I cannot agree," declares an independent inventor, to whom the self-interest of the user was urged as a sufficient substitute for a license re-

striction, "that that would be sufficient protection to the manufacturer, whose sales depend entirely upon the perfect performance universally of the articles. I have been a manufacturer long enough to know that there is nothing which so insures your future business at a profit as universally high quality, and it only takes a few cases that are spread abroad by your competitors as to the improper working of an article to have a very serious effect upon your business."

When a man invents and patents something, it generally requires more inventive ability to build up a market for it than it does to make the invention. The experience of all the ages and the ingenuity to the most advanced salesmanship is available to the man who has anything to sell. But when a patented article is to be marketed, something essentially new and unfamiliar, which the patent owner can control only during the seventeen years that the patent endures, all the resources of past experience and advanced salesmanship are together none too adequate to accomplish this purpose.

"Seventeen years," declared an officer of the Inventors' Guild, "is a very short time and conveys a very false impression. No patent of merit has ever been brought to marketable conditions, as an average, in less than about ten years. The effective life of the patent is about seven years, not more."

Marketing methods in infinite variety are suggested to the patent owner by past experience and modern salesmanship. He may sell by mail order or by canvassers; by jobbers, by retailers, or by local agents; by newspaper advertising, by distribution of samples, by advertisements in magazines, in street cars, and on bill-boards; by selling everywhere from his own office, or by territorial

division of the market; by granting discounts upon sales in large quantities, or by making favorable terms to dealers who sell no competing goods.

Perhaps each article costs the patent owner \$500. At this price, not enough purchasers can be found to make a market for the article. At a less price, purchasers may be found; but then the patent owner will not be compensated. In this situation, the royalty system comes to the rescue. The patent owner may offer the machine for \$250 or \$100 or even \$5, and obtain the balance of his compensation by charging the customer a royalty on each item of output that the machine produces. The customer, who can get possession of the machine for a nominal sum, and need pay the balance of the patent owner's compensation only after the machine has proved its efficiency and actually earned a profit for him, is satisfied. Thus a market is made for the machine, upon terms that are fair to the customer and the patent owner.

NATIONAL PERILS THREATENED BY ABRIDGING PATENT RIGHTS

The patent owner today, like the owner of any other form of property may sell, lease or otherwise dispose of all or any part of his "exclusive right." He may dispose of all of it, for use throughout the United States, or only part of it, for use in one or more states. He may grant an unqualified license, or he may grant a license limiting the user to some particular purpose. He may arrange with the manufacturer of one particular line of goods on certain terms for the use of the patented article in that line of manufacture. He may arrange with the manufacturer of another line of goods on different terms for the use of the patented article in that line of manufacture. He may fix terms on one basis for the use of the

patented article with machines of a certain amount of power. He may fix terms on another basis for the use of the patented article with machines of greater or less amount of power. He may dispose of the patented article on particular terms to customers who undertake to use it with machines bought from the patent owner. He may make different terms, or decline to deal on any terms whatsoever with customers who will not undertake to use the article with machines bought from the patent owner. Owners of other kinds of property may do all these things. There is no reason why the patent owner should not do likewise.

Bills are now pending which forbid these various methods of marketing and disposing of patented inventions. Indeed, bills are seriously being considered which would outlaw such marketing methods in respect to goods of every kind, whether patented or unpatented. So far as these bills affect unpatented goods, they are mentioned only to remark how revolutionary is the principle underlying this whole class of proposed legislation. Whatever be the argument for such proposals in respect to unpatented goods, with which the trade already is familiar and as to which the manufacturer is not limited to the profits of merely a few years, the same argument cannot apply in respect to patented articles, with which the trade can be made familiar only by the most skillful marketing methods, and as to which the patent owner is limited for his profits to the trade of not more than seventeen years, and practically to the trade of less than seven years.

Any proposal to abridge the reward for invention involves the welfare and very existence of the entire community. "For some years," says one of the greatest living patent au-

thorities, "there have been very few improvements in many classes of machines, very few radical improvements in looms for the last ten years, very few improvements in sewing machines like the Singer for the last ten years. An art grows and grows, during a tremendous struggle of competition, but finally it gets to a point where pretty nearly everything is finished. There are always opportunities for improvements in details, for refinements, every one of which adds to the efficiency of the machine, when added and correlated to the rest; but there is a time when underlying principles are worked out." During the present century, the new fields which invention can open must necessarily be fewer than those opened by the brilliant series of pioneer inventions in the century just passed. Future inventions will require greater effort, and, consequently, rewards that shall be no less than those afforded by the present

patent system. On every hand it is conceded that the efficiency of human institutions must be increased in order to cope with the increasing difficulties of existence. Never has there been greater need than now for "the fuel of interest to the fire of genius, in the discovery and production of new and useful things."

The most important agency for this purpose is invention as fostered by the present patent system. Nothing can be more reckless than to cripple at this time the chief force engaged in solving the problems of civilization.

For the future prosperity of American industries and the welfare of the entire community, it is hoped that a correct understanding of the tremendous importance of preserving the patent system, essentially in its present integrity may cure the disrespect of patent rights implied in some of the changes of the patent law proposed by Congress.



THE FUEL ECONOMIZER

By T. F. J. Maguire

In three articles preceding, Mr. Maguire discussed the comparative economy of various types of draft equipment, under the divisions of natural, forced, and induced installations. The present supplementary paper on the economizer is the natural completion of a survey of this field of power-plant engineering.—The Editors.

IN any boiler installation, the gases of combustion given off by the furnace pass over the heating surface of the boiler; and by so doing, more or less of the heat contained by the gases is transmitted to the water contained in the boiler, thereby generating steam and creating heat energy in a form suitable for commercial purposes. The temperature of the gases of combustion is at its maximum just before the gases reach the heating surface; the gas temperature decreases, until it reaches a minimum value where it leaves the heating surface and escapes from the boiler enclosure. The process of combustion is practically completed before the heating surface is reached, as the abstraction of heat is then so rapid that there is but small chance for a continuation of the process. However, a certain amount of combustion may take place while the gases are passing over the heating surface and up to the point where the gas temperature falls to 1,200 degrees F. or 1,300 degrees F.

The heat transmitted by any element of the heating surface of the boiler depends upon the temperature of the gases passing over the element, and the temperature of the steam and water contained by the boiler. As the latter temperature is practically the same throughout the entire heating surface, and as the temperature of the gases is a maxi-

mum just where the gases first impinge upon the heating surface, it follows that the nearer a given element of the surface is to the furnace, the more heat it will transmit. For equal areas of heating surface there is a difference in the amount of heat that will be transmitted, depending upon their relative positions along the path of the gases of combustion. In boilers, especially those of the water-tube type, it is probable that the first tenth part of the heating surface transmits 60 per cent or more of the total heat delivered to the water, in any given time, and that the last tenth part gives but 1 per cent, with the boiler operating at or near its rated capacity. In other words, the first tenth part of the heating surface does about 60 times as much work in a given time as the last tenth part. The further a given heating area is located from the furnace, along the path of the gases of combustion, the less will be the heat that it will transmit, and therefore the less valuable it will be as an element of the boiler. It is therefore evident that there is a limit to the extent of heating surface to use for any given size of boiler, and that this limit is reached when the additional cost of the boiler due to the added heating surface is not warranted by the decrease in the temperature of the gases.

For any given steam pressure at which the boiler operates, there is a

definite temperature for the steam and water contained by the boiler; and as the temperature of the gases must always exceed the temperature of the steam and water, in order to enable heat to be transmitted, it is evident that it would take an indefinitely large heating surface, for any given size of boiler, to lower the gas temperature approximately to the temperature corresponding to the steam pressure. As a matter of actual practice, a boiler equipment is operating at good economy if, at rated capacity, the temperature of the gases escaping from the enclosure is 100 degrees F. in excess of the temperature corresponding to the steam pressure. As an illustration, a boiler operating at rating, at 150-pounds gage pressure, corresponding to a temperature of 365 degrees F. would not, under good operating conditions, cut the temperature of the gases below 465 degrees F.

The maximum amount of heat that can be taken from the gases of combustion is the difference between the heat contained in them at the furnace temperature, and the temperature, of the surrounding air. With the apparatus now in practical use it is impossible to reach anywhere near the lower temperature limit, and indeed the practical limit is far above it. To illustrate the magnitude of the heat in the gases after they escape from the boiler, with a temperature of 70 degrees F. for the surrounding air, a furnace temperature of 2,400 degrees F. and a breeching temperature of 465 degrees F., 17 per cent of the available heat is lost so far as the boiler is concerned. Of course it is not practicable to save all of this loss, but enough of it may be recovered to make it an economical proposition, in many power plants, to install apparatus for the purpose.

The equipment used is known as a fuel economizer, and it consists of sets of straight vertical tubes, fitted top and bottom into suitable headers, the latter in turn being connected to longitudinal pipes or boxes for the proper distribution of the water to the economizer sections and for connecting the economizer to external piping. The whole is enclosed in a brick setting, a chamber being generally provided below the sections for taking care of the soot and ashes. The economizer is connected in the feed line supplying water to the boilers, usually between pumps and boilers, and is therefore operating at boiler pressure. The economizer enclosure is connected to the boiler breeching at one end, and at the other to the stack, or, if fans are used, to the suction inlet of the fans. In order to permit of taking the economizer out of service for cleaning or repairs, it is customary to by-pass the economizer by a suitable breeching connection, and of course a similar by-pass arrangement should be made for the water.

A stack alone (natural draft) is often not a practicable proposition for an installation employing economizers, on account of the excessive stack height that would be required; and in many other cases where the stack is feasible, it is not as economical as a mechanical equipment. Where a system of forced mechanical draft is used, it may happen that a stack will be more desirable than induced mechanical draft, in conjunction with an economizer, but in the greater number of cases it is believed that the induced mechanical-draft equipment will prove the more economical investment.

On account of the comparatively low temperature of the gases passing over the heating surface of an economizer, it is essential, from eco-

nomical considerations, to keep the heating surface as clean as possible. For this reason a scraper is provided for each tube, and the scrapers are continually in motion up and down the tubes while the economizer is in service, the scraper mechanism being operated by an electric motor or some other driving mechanism suitable to the plant conditions.

The flow of water through the economizer is in a direction opposite to the flow of the gases, thus putting the coldest water nearest the gases just as the latter are about to escape from the economizer setting. With this arrangement, and for a given amount of heating surface, the maximum amount of heat is transmitted and consequently the best operating economy is obtained. Unequal temperature strains are minimized and the tendency to rupture of the parts is diminished, which is particularly important as all parts of an economizer are made of cast iron.

While the economizer has certain other advantages, the principal reason for its use is that it saves enough in fuel to make it an economical proposition. Just what it saves in fuel for any given plant may be readily estimated. Any assumed boiler plant is supposed to develop, on the average, a certain number of pounds of steam per hour at a certain boiler pressure. The less the temperature of the feed water entering the boiler, the more heat will be required to do the boiler work and consequently the greater the amount of coal burned. Assume that the plant under consideration generates on the average W pounds of steam per hour at a gauge pressure of P pounds; and for simplicity, that the steam is dry saturated steam. If the fuel used has an evaporative power at the average boiler load equal to E_o pounds of water from and at 212

degrees F. per pound of dry fuel, and the average temperature of the feed water is t_f then the average dry fuel burned per hour, w , is as follows:

$$w = \frac{W}{E_o} \times \frac{Q + 32 - t_f}{965.7} \text{ pounds}$$

in which Q equals the heat in a pound of steam above 32 degrees F. As an illustration, take the case of a certain boiler plant operating at 150-pounds steam pressure, and assume that the feed-water temperature, without the economizer in use, is 80 degrees F. and with the economizer in use is 260 degrees F., under average load conditions. For these conditions the economizer would show an average saving of about 16 per cent of the coal. If the feed water delivered to the economizer had a temperature of 160 degrees F. and in leaving the economizer had a temperature of 300 degrees F., then the saving in coal would amount to 13 per cent. For any given installation the saving made by the economizer is dependent upon the temperature of the water entering the economizer; and the higher this temperature is, the less will be the gain, other conditions being the same.

The capacity at which a boiler may be driven depends upon the rate at which the fuel can be burned, or upon the number of pounds of fuel that can be consumed in a given time. If, in any given plant, a certain amount of coal can be burned per hour, it is evident that the higher the temperature of the feed water entering the boilers, the more steam will be developed by the boilers at the operating pressure. As the economizer increases the feed-water temperature, the output of the boilers in pounds of steam per hour is increased by the use of this apparatus. In other words, the capacity of the boilers is

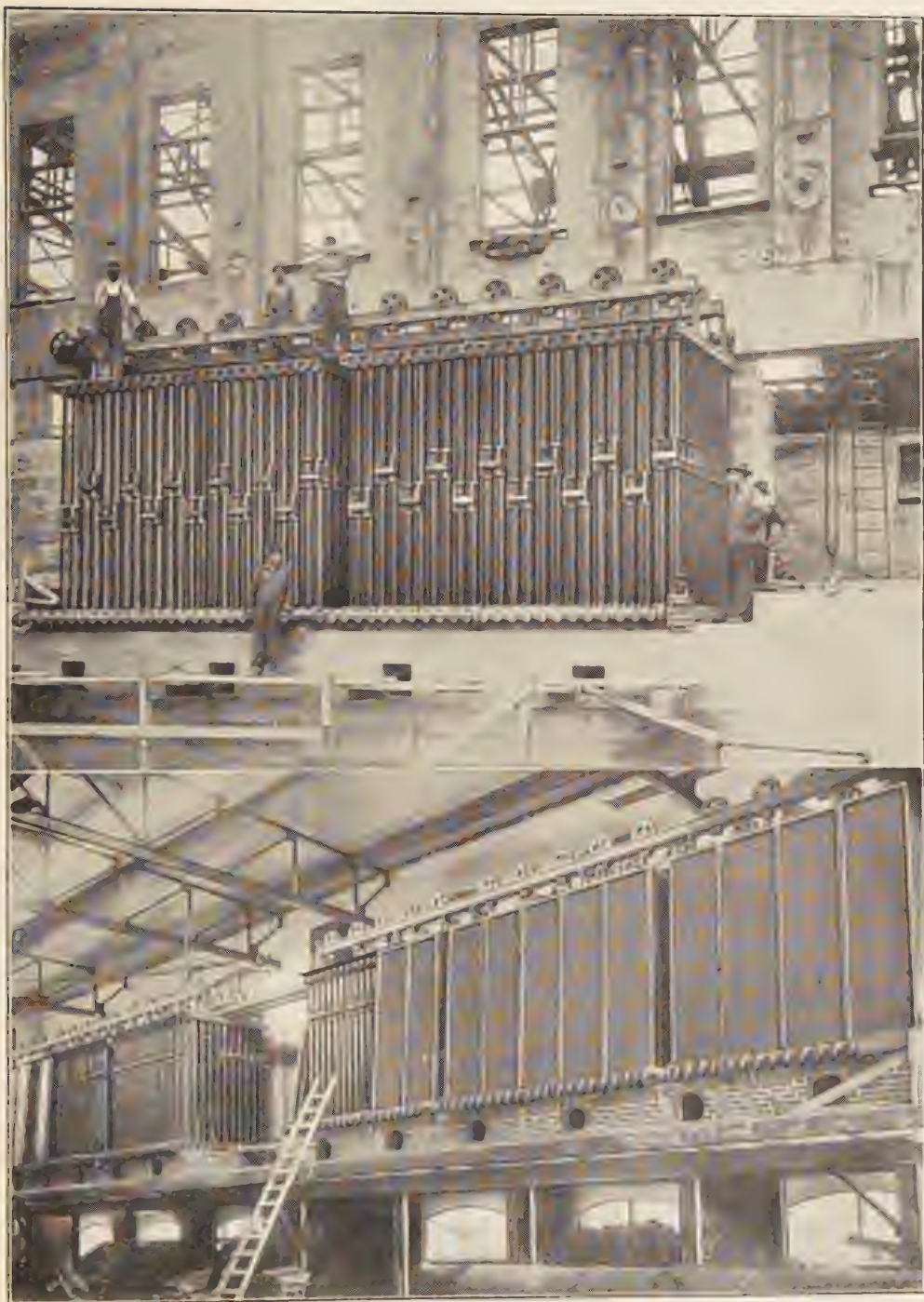
increased by the action of the economizer in raising the temperature of the feed water, and consequently a grater overload may be carried. For a given amount of coal consumed per hour, with or without economizer, the horse-power output of the boilers would be the same, but the amount of steam actually generated at the operating pressure would be greater with the economizer in use than without it. In a plant operating at 150-pounds gage pressure, with feed water at 80 degrees F. without economizer and 260 degrees F. with it, the capacity of the boilers will be increased about 19 per cent.

The use of an economizer will very often increase the operating safety of a boiler and will in addition enable the boilers to run for longer periods before it is necessary to take them out of service for cleaning. The water capacity of an economizer is usually sufficiently large to cause the water flowing through it to move at a relatively low velocity, thereby permitting solid matter held in suspension to be precipitated. A considerable proportion of the mud, clay, sand, etc., present in the feed water will be deposited in the economizer, with a resulting gain in the reliability and economy of the boilers.

Water used for boiler-feed purposes practically always contains compounds that tend to form objectionable scale in boilers. These compounds are held in solution in comparatively cold water, but are thrown out of solution when the temperature of the water is raised above a certain point. The most common scale-forming compounds are the carbonates and sulphates of calcium and magnesium. Most of the carbonates are thrown out of solution when the water is raised to a temperature of about 200 degrees F., but the sulphates are held in solution until a

temperature of 300 degrees F. or more is reached, and indeed are fully deposited only upon concentration by evaporation. The carbonate of calcium forms a loose porous scale and is not objectionable in itself, except when present in large quantities. The magnesium carbonate and the sulphates, however, form a hard, cement-like scale that if deposited in boilers is decidedly objectionable from both safety and economical considerations.

While it is necessary to raise the feed-water temperature to the temperature given above, in order to cause a precipitation of the scale-forming compounds out of solution, it is equally essential to provide sufficient volume, in such apparatus as fuel economizers and open and closed heaters, to enable these impurities to settle; otherwise they will be carried in a suspended form into the boilers. Insufficient water capacity is very often the cause of the failure of exhaust and live-steam heaters to eliminate to any appreciable extent these scale-forming compounds. The initial and final temperatures of the feed water in the economizer have an important bearing upon the value of the economizer as a purifier. The lower the temperature of the incoming water, the greater will be the volume of the economizer through which the water passes before it attains the necessary temperature to precipitate the scale-forming compounds, and therefore the less will be the time left for this precipitation. As the carbonates are thrown out of solution, for the most part, at about 100 degrees F. lower temperature than the sulphates, it follows that most of the scale-forming compounds caught in an economizer are carbonate, and that in general but little of the sulphates are precipitated. This is especially due to the fact that even if an economizer



INSTALLATIONS OF GREEN FUEL SYSTEMS

Above, at the plant of the New York and New England Cement and Lime Co., Hudson, N. Y.
 Below, at the Dan River Power and Mill Co., Danville, Va.

raises the feed water to a point considerably in excess of 300 degrees F. at the outlet, the economizer volume left for the water to travel through is too small to permit of the precipitation of the sulphates. While an economizer, especially in conjunction with a feed-water heater, can be of good service in clearing the water of sand, silt, and certain carbonates, it is doubtful if it has large value in getting rid of the more troublesome sulphates of calcium and magnesium. The higher the initial and final temperature of the water in the economizer, the more valuable it will be as a purifier; and for this reason a combination of exhaust-steam feed-water heater and fuel economizer gives good results if of sufficient capacities, the heater, in such an arrangement, increasing the effect of the economizer by supplying the latter with water at as high a temperature as is consistent with the other plant conditions.

The repair item for an economizer depends to a considerable extent upon the manner in which it is operated and the piping arrangements used with it. As the economizer is under boiler pressure, care must be taken not to lower the pressure on the economizer suddenly, as there is usually enough heat in the water contained therein to generate steam, with the result of a more or less vicious water hammer. It is advisable not to tap the feed line from the economizer for hose connections or to fill an empty boiler from it. Special care must also be taken in blowing down an economizer when under pressure. To avoid serious damage, the feed pump must be kept running to avoid emptying or partly emptying the economizer. Broken parts or sections might be caused by pumping cold water into the economizer while it is empty and hot.

The real value of an economizer de-

pends upon the saving made in the cost of fuel, and the latter evidently depends upon the cost per ton of the fuel the relative value of the average load on the plant to the full load, and the hours of plant operation. Other things being equal, the higher the cost of the fuel per ton, the more valuable will be the economizer as an investment, and the same will also be true, the higher the average load factor and the greater the time of plant operation.

In general, it is probable that an induced mechanical-draft equipment with a fuel economizer will show an increased economy over a stack alone or natural draft. Even with a forced-draft system for the furnace, a stack, as compared to the induced-draft equipment, will seldom show to advantage economically. For these reasons it is a common practice to install an induced mechanical-draft equipment with economizers.

The fuel economizer in general increases the operating economy of a plant, by abstracting heat from the gases given off by the boilers. The economizer also consumes a certain amount of energy for driving the scraper mechanism. There are many contemplated installations where natural draft or a stack would be adapted if no economizers were to be installed, and for such plants the proper comparison would be made between the stack, and the economizer with induced-draft equipment. The following example will illustrate a comparison between a stack and an induced-draft equipment and economizer. In what follows, the various assumptions made as to life of equipment, economy of operation, fuel chargeable to mechanical apparatus, etc., are values taken for the specific purpose of showing a comparative economy of the two equipments for the *particular plant considered*, and of course such

figures are liable to considerable variation for any actual plant—as well as the result deduced from these assumptions.

A certain plant consists of four 125 horse-power, 72-inch by 16-foot return-tabular boilers designed for a working pressure of 125 pounds gauge, each boiler being equipped with 27 square feet of grate area. The fuel to be used at the plant is a good grade of bituminous coal capable of evaporating 9.0 pounds of water from and at 212 degrees F. per pound of dry coal, with the boiler equipment operating at or near rating. The boiler plant is to be capable of operating for certain intervals at an overload of 25 per cent. At 25 per cent overload, with the above coal, the rate of combustion would equal about 23 pounds of dry coal per square foot of grate per hour. Allowing 0.20 inch of draft for furnace, at 25 per cent overload, 0.20 inch of draft for loss in boiler setting, and 0.15 inch loss for breeching, the maximum draft required of a stack (without economizer) for this plant is 0.55 inch of water column, and the required stack for this plant would be 50 inches in diameter and 100 feet in height above the grates. A guyed steel stack of the above size would cost about \$600.

Consider the substitution of an economizer and a suitable induced mechanical-draft equipment for the stack noted above, and assume that the average load on the plant is equal to the rated capacity of the boilers of 500 horse power. Allowing 4 square feet of surface per boiler horse power, the economizer will have a total heating surface of 2,000 square feet, and the fan of the draft equipment will have to handle, at 25 per cent overload, about 15,300 cubic feet

of gases at about 300 degrees F. and develop at this output a draft intensity equivalent to 0.80 inch of water column—0.25 inch additional draft loss allowed in economizer and connections. A 60-inch fan, operating at about 320 r.p.m. maximum, will be required and the fan system should be in duplicate to equal the reliability of the stack noted above. It is estimated that the economizer and duplicate fan equipment will cost, for this plant, \$3,300. The comparison of the two installations, for this plant would consist of a 50-inch by 100-foot stack (cost \$600) on one side, and on the other, a 2,000 square-foot economizer and two 60-inch fan outfits (cost \$3,300).

With an average load of 500 horse power on the four 125 horse-power boilers, the temperature of the gases escaping from the boilers may be assumed at 500 degrees F. and the gas temperature at the outlet of the economizer at 270 degrees F., the corresponding increase in the feed-water temperature, due to the economizer, being assumed at 140 degrees F. If the boilers are operating at 125 pounds steam pressure and the feed water entering the economizer is 100 degrees F., then the saving in coal due to the economizer is equal to 12.5 per cent for equal steam output of the boilers under the two different feed-water temperature conditions. The coal consumed to operate the induced fan equipment and tube scrapers may be taken at 2.0 per cent* of the total coal consumed with stack, in which case the combined outfit of economizer and fans would save, for the plant in question, about 10.5 per cent over the stack.

The repair and maintenance item for the 50-inch by 100-foot stack

* This is perhaps high for a properly designed plant. It necessarily varies much with varying plant equipment and local conditions. It is to be noted further that, where circumstances permit, the exhaust from the fan, scraper, and stoker engines may be used in a feed-water heater, raising the feed temperature say to 160 degrees, thus largely reducing the fuel charge against the economizer and induced-draft installation.



STURTEVANT ECONOMIZER INSTALLATION OF 396 PIPES, 36 IN. DIAMETER, EQUIPPED WITH TWO TO BY 5 INDUCED-DRAFT FAN -
For the Union Light, Heat and Power Co., Fargo, N. D. By the B. I. Sturtevant Co.



GREEN FUEL ECONOMIZERS, ERWIN COTTON MILLS, WEST DURHAM, N. C.

would consist simply of the cost of painting the stack once a year at a yearly cost of about \$25. The same item for the fan and economizer installation would cover the cost of all repairs to fans and economizer as well as cost of gaskets, packing, lubricating oils, etc. It would not be unreasonable, for the plant in ques-

tion, to assume an average repair and maintenance item for fans and economizer of not less than \$75 per annum.

If the plant operates 12 hours per day and 6 days a week, and coal is worth \$2.50 per ton delivered in front of boilers, then the economizer and induced fan equipment will save \$992 per year in coal (5 per cent

moisture assumed for coal) over the stack. If a life of 10 years is assumed for both equipments and an interest charge of 5 per cent is taken for depreciation and interest charges on the investments, then the annual interest and depreciation charges for the stack will amount to \$78 and for the economizer and fan equipment \$428. Allowing for the saving in fuel due to the use of the economizer and induced-draft equipment, the total annual saving due to the economizer over the stack is \$592.

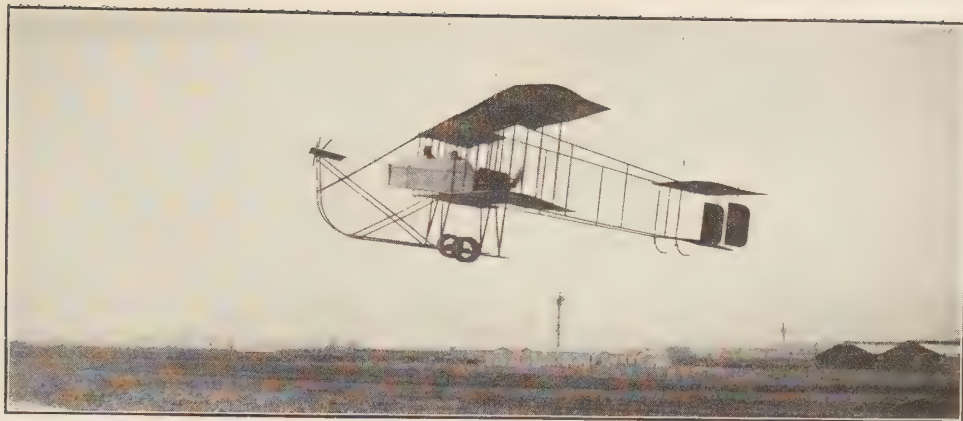
The mistake is very often made, in estimating the profit due to an economizer equipment over a plain stack, of assuming that the yearly profit is equal to the *gross* saving in coal due to the increase in the temperature of the feed-water as brought about by the economizer, no mention being taken of such important items as maintenance and repair, interest and depreciation on investment, etc. All of these latter items are almost always favorable to a stack, and hence such a method of comparison is decidedly incorrect and misleading. In the example taken above, the annual *gross* saving in coal was \$1,181, while the actual saving taking into consideration all items was \$592, or practically one-half of the former.

In favor of the economizer it must be observed that for large installations, such as central stations and traction power plants, other and generally controlling arguments for the stoker installation come into play. In such a station it would no doubt be the practice to install stoker equipments, driving the boilers continuously, at the rate of a boiler horse power for 5 square feet of boiler surface, or even less, instead of the approximately $8\frac{1}{2}$ square feet assumed in the example above. The $3\frac{1}{2}$ square feet of surface thus cut off from the boiler might be replaced by

$1\frac{1}{2}$ to 2 square feet of economizer surface, preserving the same final temperature and over-all efficiency. As boiler surface installed costs about \$2 a square foot, and economizer surface installed but \$1.20 per square foot approximately, there would be a gain in economy of installation.

The comparison carried out in this article, however, is intended for small plants, not for large stations, and in a relatively small installation, such as chosen above, consisting of four 125 horse-power boilers, the real value of the argument last stated becomes doubtful. Considerable variations of the values assumed for cost of coal, depreciation, coal used by fan and scraper, etc., must of course be expected and allowed for in considering any specific plant.

There is no question but that the fuel economizer is a valuable piece of apparatus for boiler installations in general; but just how valuable it is depends of course upon many items of plant design and operation. No general rule is applicable, and the *gross* saving in coal per annum is not the proper criterion to go upon. Under favorable conditions, an economizer equipment increases the operating economy of the plant, increases the maximum output of boilers for the same rate of fuel combustion, maintains the interior of the boilers in a cleaner condition and hence permits longer intervals, generally, between cleaning, and provides a comparatively large amount of hot feed water for emergency use. This last advantage is quite important, especially in plants where a sudden and large increase in the load is likely to occur in a comparatively short interval of time. But like any other engineering equipment, an economizer installation must be intelligently installed and operated, to secure the savings possible from its use.



FARMAN BIPLANE, MILITARY TYPE. SEE PAGE 409

AEROPLANE CONSTRUCTION AS SHOWN AT THE PARIS AERO SALON

By Capt. Horace B. Wild

In a preceding article published in our April issue Captain Wild directed his attention solely to engineering questions concerning aeroplane motors. The present paper considers the mechanical and structural details of aeroplanes.—THE EDITORS.

TO judge from the exhibits of aircraft displayed at the Paris Aero Show, in both quantity and quality the monoplane is rapidly elbowing the biplane out of existence. There were exhibited thirty-eight monoplanes and fifteen biplanes, and there was no instance in the Show of a triplane or multiplane, in spite of the fact that at the military trials there were two machines of the first order, both of which proved tolerably successful. Hitherto the biplane has been regarded essentially as the weight carrier, and the monoplane as a speed machine for solo work. It would appear, however, that from this time forward no such differentiation is to be made. For one thing, the monoplane is now made to carry as much weight as the biplane, or more, whilst the latter, we can justly say, is being rapidly brought into line with its rival in point of speed qualities. It is therefore only nat-

ural to find that the biplane is being constructed under strong monoplane influence; indeed, it resembles the latter type of machine, with few exceptions, in almost everything except the number of planes employed. The older type of biplane with tail behind and elevator in front has now practically disappeared.

DIFFERENT TYPES AND SPEEDS

It is clear enough that in both types the point has been realised that it is the wiser plan to keep the power of the motor the same and alter the rest of the design to obtain greater speed than to consider the machine itself as final and increase speed simply by augmenting engine power. High speed, in fact, was the dominating feature of the Show, and one may almost say that every machine shown there, whether biplane or monoplane, was a speed machine purely and simply. No doubt it is because of this desire for speed that

the biplane of the original type has failed to hold its position.

Incidentally one may note that speeds which in England are certainly regarded as very high indeed are looked upon in France as quite ordinary, where sixty miles an hour is considered comparatively mediocre for a monoplane, and anything less than fifty miles an hour quite absurd. Any one who can show a speed of between eighty and ninety miles an hour is thought to have done something worth the doing, but even higher speeds are glibly talked of. American built machines average in speed from thirty-eight to sixty-five miles an hour.

ENCLOSED FUSELAGE

Everywhere one could see that great efforts have been made to reduce head resistance in every shape or form. Fuselages, if not made of strictly fish-shape form, are very carefully covered in and the pilot shielded as far as possible. In many cases the engine is nearly, if not completely, encased, whether it be of the stationary or rotating-cylinder kind. Everything is made as simple as possible. In some of the machines intended for military use the fuselage is built completely of metal, either being formed of a sheet-steel hull or built up of tubes. Steel as a material for use throughout the aeroplane appears to have made much headway.

In wing sections there seems to be a tendency to adopt that which is known as the Horatio Phillips type, and no doubt this may be ascribed to the success of the Nieuport machine, which, it is perhaps not too much to say, forms the parent type of nearly every monoplane in the show. At the same time, as there is a thickening of the front edge of the plane, it is not uncommon to find a slight turning up of the trailing

edge, so that in section the plane is represented by a very flat letter S. The dihedral angle between the wings, although as popular as ever, does not exist to so pronounced a degree as hitherto. There are, on the other hand, a good number of monoplanes which have no dihedral angle at all.

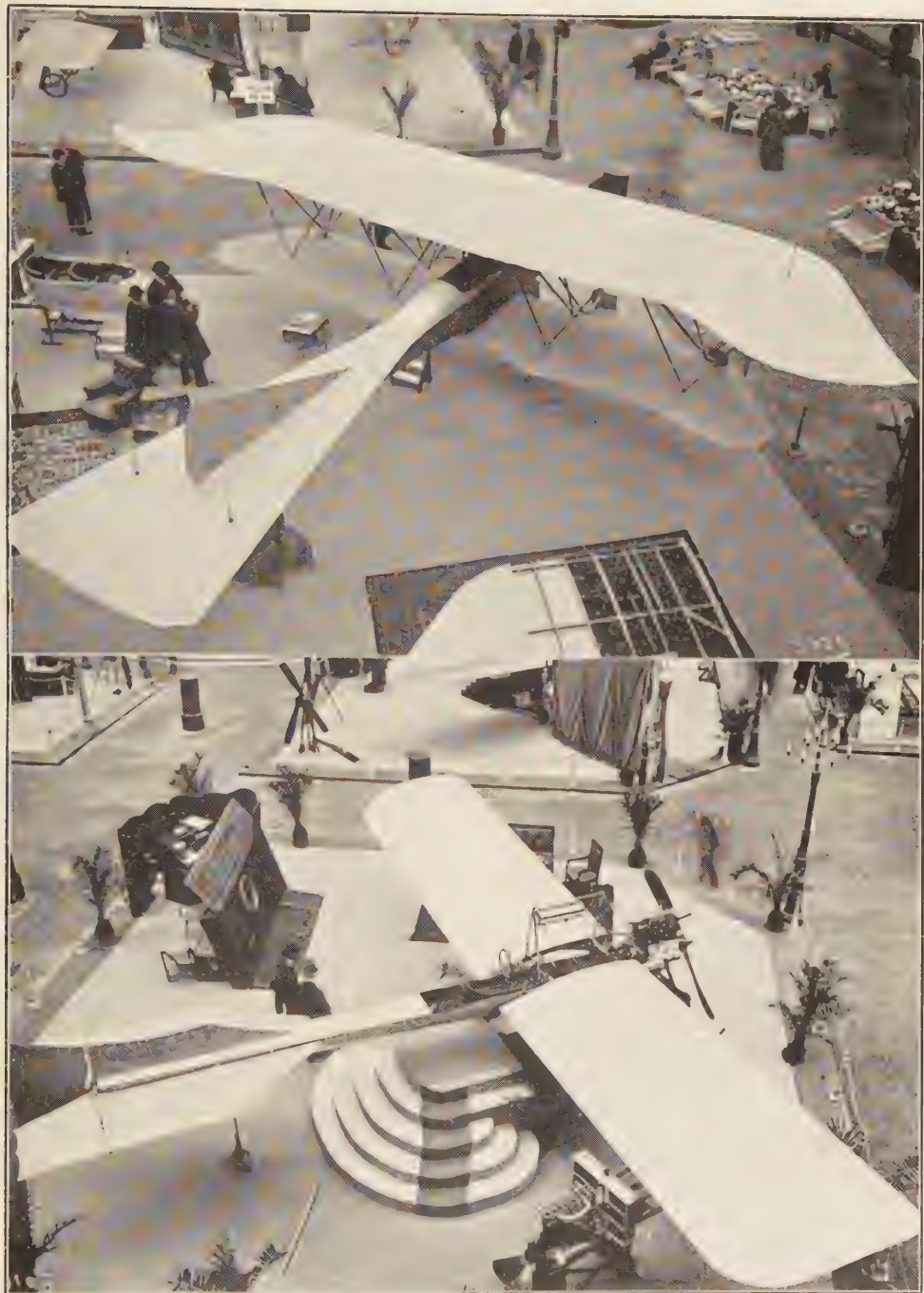
In biplanes it is now the exception to find the planes directly over one another, the rule being to have the upper plane considerably in advance of the lower one, in the fashion started by Goupy. This method of construction may also be ascribed to the demand for higher speed, although it is difficult to see how it can be of much more than negligible effect.

POPULARITY OF THE NON-LIFTING TAIL

Despite the classic Antoinette being a notable absentee from the exhibition, its influence is very clearly to be seen in the general popularity of the non-lifting tail, which is now practically universal. There were, however, a few notable exceptions, the reason behind which close inquiry has failed to divulge. Amongst the non-lifting tails one finds planes having a positive camber with no angle of incidence at all, planes of bulged stream-line section cambered both ways, and also perfectly flat planes. Designers appear to be undecided which form is the best.

Simultaneously with the use of a purely directional empennage has come the general raising of the center of thrust, which is, of course, naturally most apparent in the biplane class.

Another development which has followed upon the employment of the non-lifting tail is a slight change in the relative position of the main organs of the machine. Thus one finds the wings rather further back than usual, with the pilot and the engine brought as far forward as possible.



THE ALBATROSS BIPLANE, AND THE AVIATIC MONOPLANE

The result is that, as a rule, machines are considerably longer in the body than hitherto.

Although the use of a fixed stabilising flat tail plane is still customary, several instances were to be found of the tail as a whole being movable, and opinions appear to be about equally divided as to whether such plane should be balanced or merely hinged as a flap.

NEW-TYPE LANDING GEAR

The up-to-date landing gear is certainly becoming simpler, lighter, and of less resistance than previously, but it is quite open to question whether any real improvement has been made as landing gear. In this respect the 1912 machine, especially that of the high-speed type, leaves a good deal to be desired, and one may say without much fear of denial that it is likely to prove somewhat difficult to manage unless handled by an expert and flown over the very easiest of country.

Skids are evidently not considered as important as they used to be, for they have in almost every case shrunk considerably, and now appear to do little more than act as an anchorage for the running wheel spindles, or as a rudimentary protection for the propeller. One can only conclude from some of the principal machines that their construction is considered to be strong enough to take a good deal of hard shock without damage. The use of shock absorbers of various kinds certainly seems on the decrease. In some cases no shock absorbers whatever are fitted, though these are admittedly exceptional. Only in very few cases is provision made to ensure that in no circumstances can the machine itself feel the direct shock of landing, however hard that landing be. Running wheels are, generally speaking, larger in diameter and shod

with larger tires than usual. There is a tendency to insulate the bracing of the wings of the machine from the landing gear and to make the two altogether independent.

DUPLICATE CONTROL

In respect of control one is glad to see that machines are becoming more and more standardised, that almost universally adopted being a steering wheel, rotation of which warps the wings. Pulling the wheel-pillar backwards and forwards operates the tail plane, whilst the rudder is actuated by a single rocking pedal or a couple of inter-dependent pedals. Not infrequently the rudder is coupled up with one of the running wheels to make the machine more easily steerable when on the ground. On most of the military machines (which were in nearly all cases passenger-carrying types), the control is fitted in duplicate.

LEADING EXHIBITS

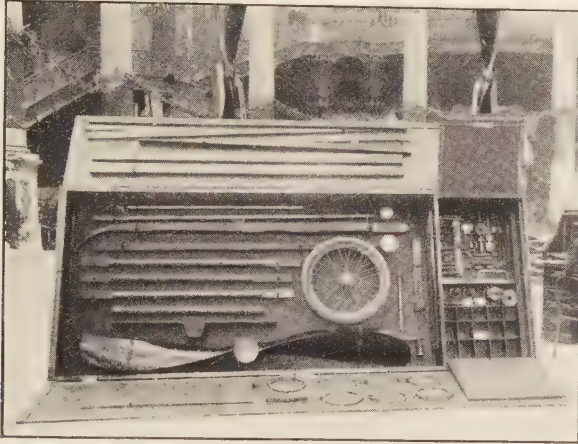
The Albatross and Aviatik machines represented the German industry at the exhibition. The main planes of the Albatross are staggered, all the bracing between them being accomplished by ferruled wooden struts, of which there are rather a large number. The lower plane is considerably smaller than the upper, and both are designed upon what may be called Etrich lines. In common with most of the biplanes exhibited at the show, the wings are double-surfaced.

Lateral control is by warping the turned-back tips of the planes. The fuselage is entirely covered in, and carries a non-lifting triangular fixed tail plane, behind which is an unbalanced elevator flap, and above which is a large triangular balanced rudder. The machine is a two-seater with passengers arranged in tandem.

The engine is a large four-cylinder water-cooled type, and the radiator

is very neatly arranged to form the bottom surface of the curved-up fuselage.

One very good point on this machine is the fact that the converging struts which carry the skids, upon which wheels are mounted in Farman fashion, are not rigidly connected to the skids, but are taken to a short semi-elliptical leaf spring,



AVIATIC TOOL KIT

which entirely prevents a direct shock to the machine when a landing is made, however harsh it be. In addition to this, each skid is strutted so as to be independent in working of the other.

AVIATIC

This is a German monoplane on lines which in general resemble those of the Antoinette, although the chassis is quite different, being more like that of the old Hanriot in general arrangement. The fuselage is practically triangular in section, the sides being slightly belled out. The tail is non-lifting, with a single large elevator flap, and is protected by a skid furnished with a small trailing wheel. The main supporting surfaces follow in section the lines of the Etrich, having a pronounced turned-up trailing edge. Compared with most of the monoplanes shown, the Aviatik, although a beautiful piece of work, is rather behind the

times, as neither the engine nor the pilot is in any way protected, whilst the oil reservoir hung on the triangulated mast is now considered a thing of the past. The engine is a four-cylinder 100 horse-power Aviatik, with an aluminium radiator arranged immediately underneath it about the fuselage. The four exhaust pipes are struck somewhat artlessly up in the air to keep the exhaust out of the pilot's eyes. The chest of tools and extra spares exhibited at the Aviatik booth was unique and showed the superiority of the German manufacturer.

BLERIOT

This firm had an exhibit well worthy of its great name, there being no less than four machines on the Bleriot stand, as well as two others on other parts of the floor. In general little change has been made in the monoplanes, except greater perfection in detail, better covering of the pilot, etc. Two entirely new models, however, have been brought out. The first is a school machine or "Type Populaire," which is sold complete at a very low figure. It follows the original Type XI fairly closely, having a lifting tail at the end of the open fuselage, whilst the tail elevator is of the upturned type. The landing chassis, however, is considerably modified, reduced in dimensions and head resistance, very rigidly indeed and slightly raked as to angle. The whole machine stands less distance from the ground than the original type. The engine is a 30 horse-power Anzani, up to which the fuselage is neatly tapered, whilst, to prevent oil being thrown back, there is a metal shield covering the crank chamber almost entirely.

It is rather interesting to note that the speed of this small machine is a little higher than the 50 horse-power

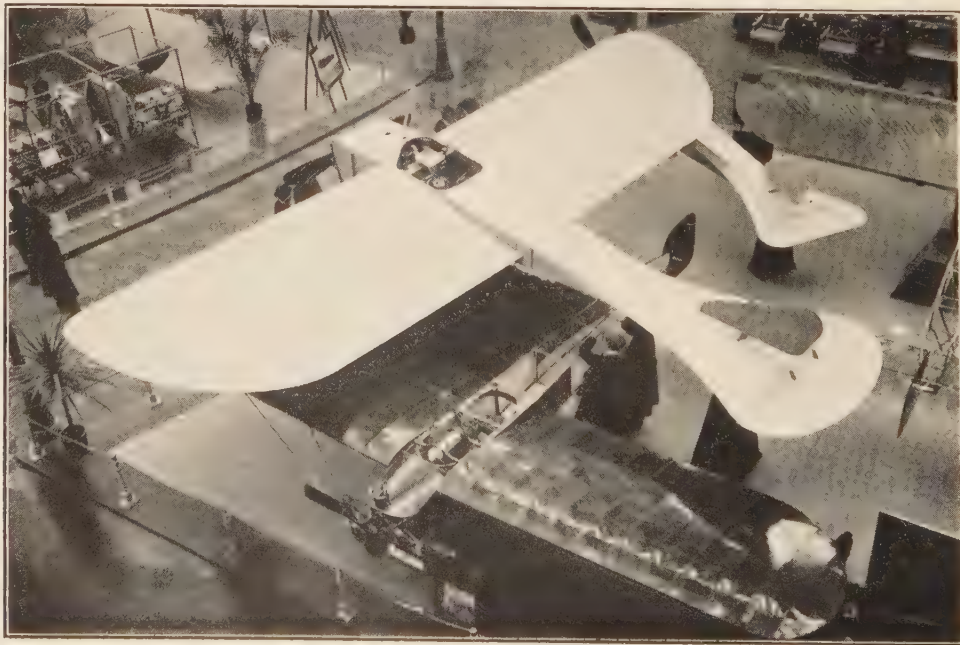


BLERIOT LIMOUSINE

single-seaters of last year. One of the latest pattern of this latter type represents speed specialisation to perhaps a higher degree than any other machine in the show. The fuselage is entirely covered in, being splayed out in the rear to form a fish-tail empennage, which terminates in a large elevator flap forming a non-lifting tail in contra-distinction to the smaller machines. From the trailing edge of the wing to the nose

the fuselage is covered in with a metal bonnet, on one side of which is a removable panel for gaining access to the carburetter, magneto, etc. The former is brought very low down to one side with a long elbowed inlet pipe to allow room for a very large petrol tank, which is also enclosed under the bonnet.

The other Bleriot machines shown on the stand are a standard 50 horsepower single-seater with lifting tail



THE BLERIOT EXHIBIT

of the old pattern, and a two-seater military monoplane with a 70 horsepower Gnome engine and with seats side by side. This latter has the splayed out fish-tail empennage.

BLERIOT LIMOUSINE

The big Bleriot touring aero car, built for M. Henri Deutsch de la Merthe, created a great deal of attraction, and is perhaps the largest

resistance has received apparently very scant attention indeed, and no doubt this accounts for the comparatively low flying speed of the machine, viz., forty to forty-five miles an hour.

BRISTOL MONOPLANE

The Bristol monoplane, which formed the sole English exhibit amongst the complete aeroplanes, at-

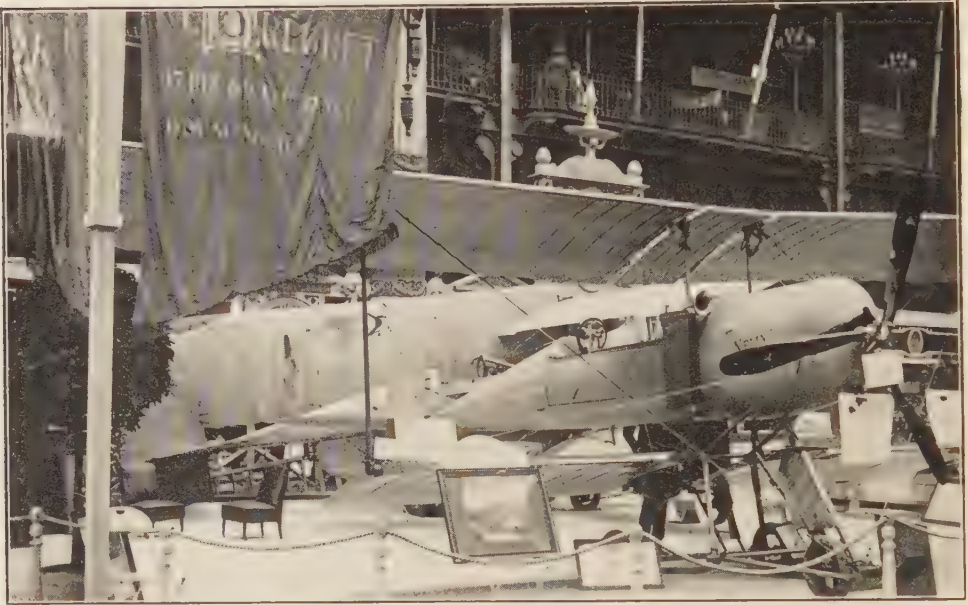


BRISTOL MONOPLANE

monoplane that has yet appeared. The illustrations show its general arrangement. In front is an elevator worked in conjunction with the tail flap in the rear. The pilot sits immediately in front of the limousine type of body, which holds four persons quite comfortably, and is furnished with mica windows. Immediately behind and above this body is a fourteen-cylinder 100 horsepower Gnome engine driving a Normale propeller direct. The landing chassis is of the usual Bleriot type, though, of course, considerably enlarged and strengthened. The question of head

tracted a great deal of attention not only by reason of the fact that it is British, but also because it is generally acknowledged to be quite the equal of any machine in the Show. This particular type, which was designed by Pierre Prier for the Daily Mail Circuit of Britain, has undergone several small changes since its original inception.

In plan the wings are almost perfectly rectangular and have only a very slight dihedral angle. The fuselage, which seats two people, one behind the other, is rectangular in section and completely enclosed. It is

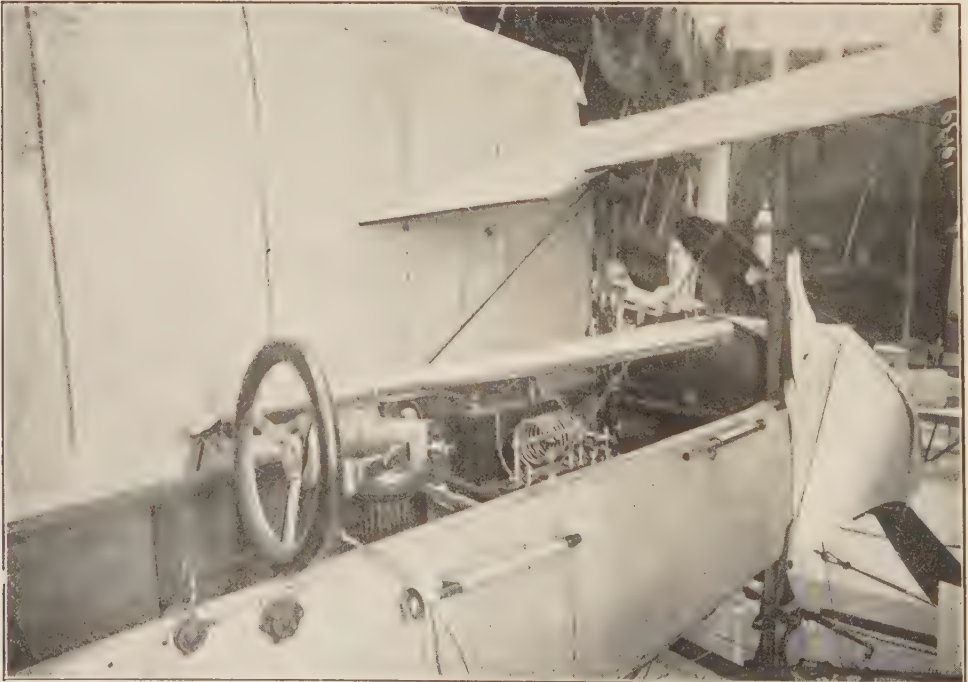


BREGUET MILITARY TYPE

sharply inclined upwards immediately in the rear of the engine, firstly to reduce resistance as far as possible, and secondly to make the engine more accessible than it usually

is in this situation. The latter is a 50 horse-power Gnome, and is pretty completely covered in so far as regards oil throwing.

The landing chassis is one of the



COCKPIT OF BREGUET MILITARY TYPE

most complete in the exhibition, having skids long enough to be of some practical use. In front each terminates in a turned up "toe piece," which is freely pivoted and bends upwards against the action of a short spiral spring. This not only acts to a certain extent as a shock absorber, but also as a brake. The running wheels are at the ends of a single axle, which is fixed to the skids with the

nose of the fuselage, the lid of which is removable. Radiators are arrayed at each side of the fuselage.

In one of the biplanes on exhibition there was mounted a rapid-firing gun pivoted on the steering post in unique manner, capable of discharging twenty-four shells in rapid succession or at the will of the gunner. Also mounted as shown in the illustration on the same machine was



BOREL MONOPLANES

ordinary type of shock absorber. Under the rail is a small semi-circular buffer of this wood.

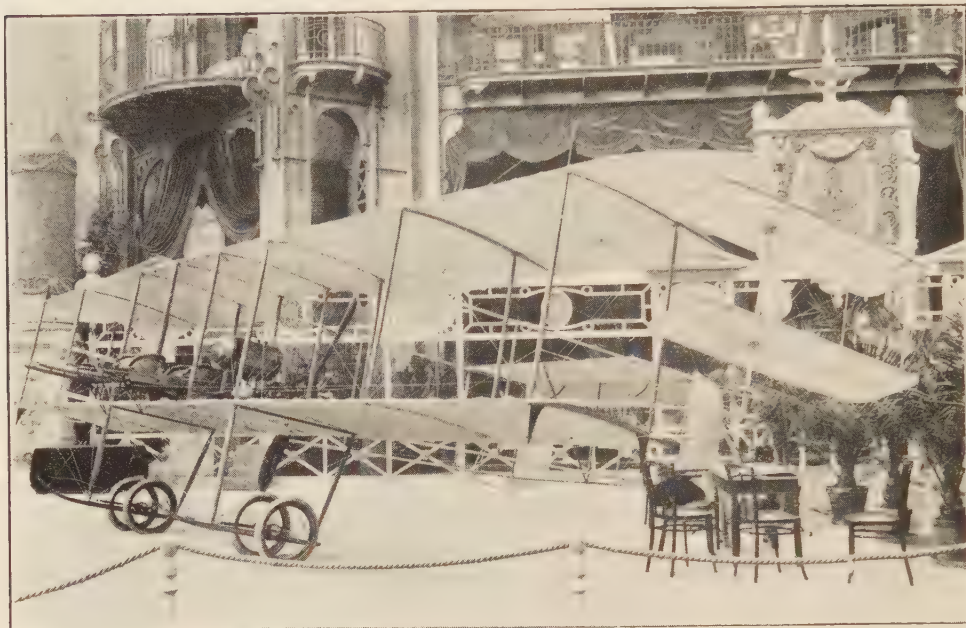
LATEST MILITARY TYPE OF BREGUET TWO-SEATER

These well-known biplanes, or monoplanes, as for some strange reason their designer prefers to call them, exhibit no marked change. The most striking model is a two-seater, in which a very comfortable side-entrance body is incorporated in the metal fuselage. The engine is an 80 horse-power Chenu, and drives a three-bladed Breguet propeller, with adjustable pitch through 2 to 1 gearing. It is totally enclosed inside the

a complete wireless aerial equipment. The workmanship is excellent throughout and the machines as here shown have carried as many as eleven passengers.

BOREL MONOPLANE

This machine maintains all its original characteristics, amongst which is the setting of the wings with practically no dihedral angle at all. The motor is a 50 horse-power Gnome, which is fairly well shielded with metal "cheeks" in the sides of which ventilation ports are cut. The seat for the pilot is quite luxuriously padded round. A peculiar feature of the Borel is the design of the tail,



BRONISLAWSKI BIPLANE

which is of the original Bleriot or lifting type, and is controlled by a rear flap formed into one with the pivoted wing tips, the purpose of which is to provide the elevator with a modicum of balance. Another feature which catches the eye is the unusual size of the rudder—a wise provision in a machine in which the warp, owing to the shape of the wing tips, exercises an unusually powerful moment.

BRONISLAWSKI BIPLANE

This is a biplane which appears to be exactly of the latest Henry Farman type, with the exception, however, that it is fitted with a new form of control for which great advantages are claimed.

Between the wing tips, which are brought to a point, is mounted a vertical shaft, which carries fixed permanently upon it a couple of horizontal planes set at an angle with the shaft. Normally these planes trail behind the shaft, and therefore have no effect upon the machine at all. Wire from the control gear pass

round a drum on the vertical shaft, and allows the planes to be rotated to a certain extent, when it will be seen the pair at one tip gives itself a positive angle of incidence, whilst the pair at the other tip gets a negative angle of incidence, and the required horizontal turning couple is thus formed.

It is claimed for this device that in regaining lateral stability there is no need to use the vertical rudder at all; that, in fact, this organ requires to be used only in turning, whilst the fact that the rotatable subsidiary planes behave as turned-up tips is also claimed to contribute towards the natural stability of the machine.

CLEMENT-BAYARD

Practically the whole of the Clement stand was taken up by a Gargantuan dirigible nacelle complete with engines, two huge propellers, transmission gear, etc. The only aeroplane shown (this firm manufactures the "La Demoiselle") is a very fine *Type Militaire* biplane, or Avion as the official mind has dubbed army

machines. This machine is practically the Clement monoplane with an additional deck of wings. Of these the upper deck is considerably the greater in span.

The construction of the machine is principally of metal, the fuselage being of aluminium. The engine, a four-cylinder vertical, is in a compartment at the extreme nose, the front being formed of multiple-tube radiator, through the middle of which passes

late construction, represents perhaps the highest note that has been struck yet in biplanes.

DEPERDUSSIN MONOPLANE

These well-known machines appear to remain almost exactly the same as they have been during the past year, except for the fact that a couple of military models, a single seater and a two-seater, have been introduced. They follow, however, exactly upon the lines of the ordinary sporting



DEPERDUSSIN MACHINES

the propeller shaft. The engine compartment is ventilated by a series of louvres on each side of its bonnet, which is removable. The landing chassis is composed principally of steel tubes; the skids, however, are of wood.

The non-lifting tail plane is set neutrally, and is cambered as to both its upper and under surfaces. The elevator flaps are bat-wing shape. Seats are provided for pilot and passenger tandem fashion.

In general the design of this machine, to say nothing of its immacu-

"Deps," except that the nose of the fuselage is made of metal, carefully designed with regard to the reduction of head resistance. On the larger machines of this marque—namely, the two-seaters—the triangular tail plane is cambered as to its upper surface and dead flat as to its lower, while on the single seaters the empennage is the ordinary lamina.

HENRY & MAURICE FARMAN MACHINES

The Farman brothers exhibited a Maurice Farman biplane and a Henry Farman monoplane. The former is

upon traditional M. F. lines, and is a machine similar to that entered in the French military trial, except that it has staggered planes. The engine is a 60 horse-power air-cooled Renault, and the biplane is notable principally for the fact that it is fitted up with a very neat wireless-message sending station, in which it is, in the future, intended to use the wire bracings of the machine as the principal



DE MARCAY-MOONEN

part of the "aerial." No provision is made for receiving messages. In the matter of control, the machine is much the same as the original type of M. F., but the wheel for operating the ailerons is now superseded by a couple of spade-handled levers forming a kind of rocking lever. Pressing these forward operates the front elevator, which is interconnected with a flap on the tail, while the biplane rudder in the tail is actuated by a couple of interconnected pedals.

The Henry Farman military type monoplane was on much the same lines as most of the others in the Show. The Gnome engine is sup-

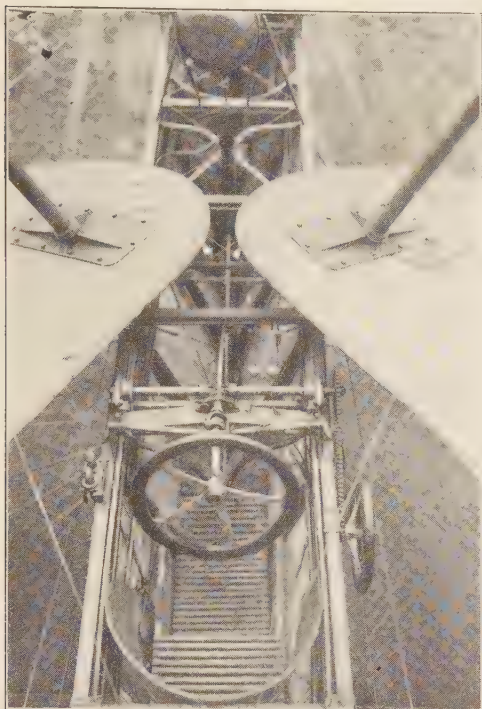
ported inside the dome-fronted metal nose of the fuselage, pear-shaped holes being cut for ventilation. The motor appears to be somewhat notably inaccessible, although a mica window is inserted at each side of the housing for purposes of inspection. The tail is non-lifting, with a very large fixed plane. A pair of wheels at the ends of a common axle slung with rubber bands form the landing chassis. The fuselage is completely covered in with fabric, and is turned up sharply at the tail end.

DE MARCAY-MOONEN MONOPLANE

This is one of the few really original ideas in the Show, and consists of a monoplane on more or less standard lines, except for the outstanding feature that the wings are pivoted at their inner ends and can be folded back upon the fuselage, not only to make transport by road as easy as possible, but to allow the angle of incidence and the setting of the wings to be altered to suit particular flying conditions. The De Marçay-Moonen monoplane is thus within certain limits a machine of which the speed can be considerably varied. The wings are built up each around a stout steel pillar, the two of which are inclined apart at the top. In this manner, as the wings are moved backwards and forwards, the angle of incidence is altered. The pivoted pillars are so arranged that they are relieved of the greater part of the lifting strain, this being taken by the usual triangulated guys.

The leading edges of the wings are connected by a stout cable, which passes over a pulley block in the forefront of the fuselage, while the trailing edges are similarly connected, but in this case the cable is extended to pass over a drum, by which the movement of the wings is con-

trolled. At present this operation can be carried out only on the ground, but in future machines it



COCKPIT OF THE DE MARÇAY-MOONEN MONOPLANE

will be possible to make adjustments to a limited extent when in flight. The folding back of the wings is accomplished by a hand wheel at the side of the fuselage, but the same action is also used for the control instead of warping. The control wheel is connected to the middle bevel pinion of a small differential gear, which causes one wing to be pushed forward, while the other is pulled back. This gear is arranged so that it can be disconnected entirely from the main wing setting, so that it does not interfere with the wings being folded up at all.

MORANE-SAULNIER CROSS-COUNTRY MONOPLANE

The military machine is an extremely formidable affair with a submarine type of fuselage, entirely made of metal. This appears to be

of immense strength, though undoubtedly heavy. In front it is rounded off, and the engine, which is a 100 horse-power Gnome, is placed inside, there being a ring of six holes each about 4 inches in diameter, to allow air to impinge upon the cylinders. Behind the engine is a bulkhead space, air being exhausted from the engine chamber by a large inverted scoop or cowl each side. Above this is a mica window, presumably intended for the use of the "look-out" This machine was shown in an unfinished state, only a portion of the wings being mounted. The framework of these is entirely of steel tubes, the joints being made by acetylene welding.

In the design of the wings a tendency to get away from the accepted type of plane section is very evident. Here one perceives the Horatio Phillips type of plane carried to extremes, and it is evidently intended to have a very sharply angled interruption in the under surfaces. In default of practical results from this type of plane, one may suggest the probability that the centre of pressure will be a somewhat variable quantity as regards disposition, especially in view of the fact that the machine is intended for very high-speed work. The landing chassis appears to be of great strength, and is composed principally of elliptical section steel tubes. The skids are rudimentary, while the tail is of the lifting type.

NIEUPORT MONOPLANE

The winners of the French military trials are represented by several models, including the identical machine that proved victorious. No changes of any note are to be seen, a view of the booth shows the well-known Nieuport lines as exemplified in a high-speed single-seater, with 50 horse-power Gnome engine. This



THE NIEUPORT EXHIBIT

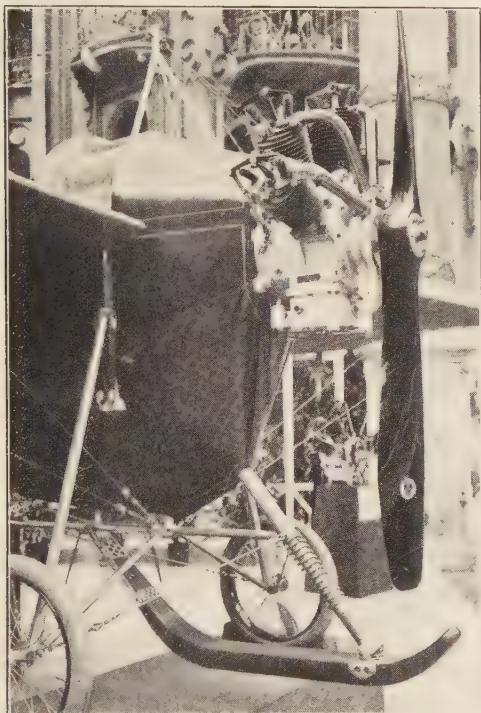
latter is almost entirely enclosed, the carburetter, magneto, etc., being got at through doors on each side of the fuselage, which is at this point covered in with metal. The pilot is

protected very well, indeed, and it is probable that the total head resistance of this machine is as small as that of any other machine at the Show. The upturning of the trail-



THE R. E. P. EXHIBIT

ing edge of the wings is just a little more pronounced than usual, the "Phillips entry" being adhered to as regards the front edge. The landing



FRONT OF THE R. E. P. MONOPLANE

chassis consists of a single central skid with a wheel each side, carried on a cross-axle consisting of a single laminated leaf spring, the wheels being splayed outwards to allow the machine to land a little canted over without undue strain. The front of the skid, which is of steel tube, consists of a metal spoon intended to prevent any possibility of the skid digging into the ground.

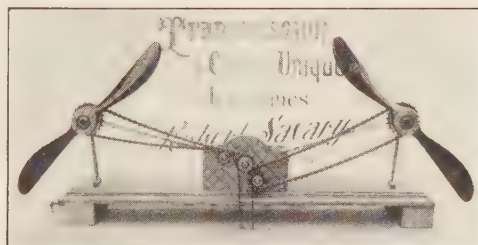
ROBERT ESNAULT PELTERIE MONOPLANE

The new R. E. P. monoplane, which retains its characteristic show-coat of scarlet, is slightly smaller than previous models which it resembles in such principal points as tubular steel fuselage brazed together with lugs, wings with slightly turned-up rear edge, cruciform

non-lifting tail, and individual landing chassis. The last consists of a large hollow wooden skid, which is provided with an oleo-pneumatic shock-absorbing device and is arranged independently of the running wheels, which are also sprung and pivoted independently of one another, their axles being articulated to a central fixed pillar, which is covered in by the "breast" of the enclosed fuselage. The control is instinctive by a single hand lever on the right hand side. A 50 horse-power five-cylinder R. E. P. motor is used.

SAVARY

This is one of the few biplanes in the Show which appear to have escaped—or repulsed—monoplane influence. It is of the front elevator-less type, with a non-lifting biplane tail, the fixed planes of which form nearly an equilateral triangle. The empennage contains no vertical rudder at all, this organ being displaced by four pivoted vertical panels (balanced), which are arranged two on each side of the main planes. Change in direction in the horizontal plane is obtained by twisting one pair of these panels so that the resistance



SAVARY CHAIN DRIVE

upon that side of the machine is increased, this operation being carried out in conjunction with the actuation of aileron flaps which are let into the trailing edge of the overhanging wing extensions. The fuselage provides accommodation for three persons, two in front and one behind. At the extreme forefront a



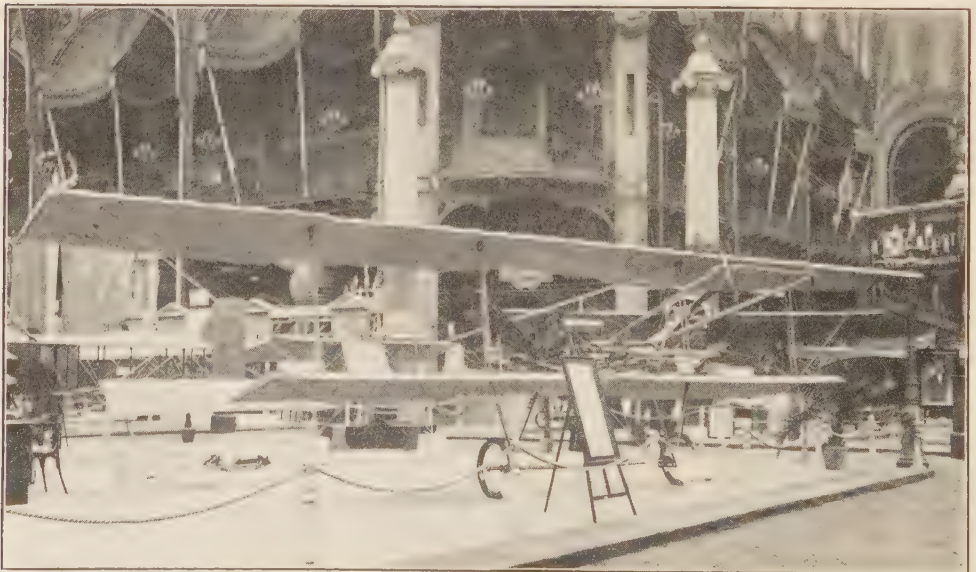
SAVARY BIPLANE

four-cylinder vertical engine is carried, and in front of that a large rectangular radiator. There are two screws, both tractors, and these are driven in opposite directions by a single chain, which is arranged in the ingenious manner shown in the illustration. The engine-shaft carries two chain pinions of equal size, one of which applies to one part of the chain and the other to the other. The propeller centers are sufficiently far apart to enable the passengers to sit clear of the slip-streams, and, of course, they are also protected by

the engine, etc. The landing chassis consists of a single central skid, on either side of which are a couple of sprung castor-wheels.

SOMMER MACHINES

Two complete Sommer machines were shown, a monoplane and a biplane. The biplane is the more interesting machine of the two, but can hardly be regarded as very far in advance of the practice of two years ago. Its chief peculiarity lies in the fact that it is constructed of steel tubing and that the usual row of



SOMMER BIPLANE

rear struts between the wings is done away with. Otherwise the machine is of the original Sommer pattern. The monoplane tail is slightly cambered, but set at a neutral angle. In the rear it has a hinged elevator flap and underneath a couple of large rudders.

The front elevator, which is interconnected with the tail flap, is practically elliptical in plan and of extremely small size, so much so, in fact, that one wonders what use it

within the fuselage, and co-axial with it. The engine drives the propeller at the extreme rear through a long propeller shaft entirely free from universal joints, and slung upon ball bearings at intervals. The motor itself is in a veritable engine room, ventilated by means of louvres each side which, when removed make the engine, in spite of its enclosed position, thoroughly accessible in every part. Needless to say, the great advantage of such a construc-



PAULHAN TATIN

can be. It is supported by a couple of plain tubes from the nacelle, which carries two seats in front.

TATIN

Quite the most original aeroplane, as well as easily the fastest, was the Paulhan-Tatin aero-torpedo, practically following the lines of several model fliers made many years ago by M. Tatin, which were amongst the very first of their kind. The fuselage carries its organs in an entirely novel manner. In the immediate front is a wind-cutting head, behind which the pilot is accommodated. At his back is a fifty horse-power Gnome engine, completely enclosed

tion is that head resistance is reduced to an absolute minimum, and which is easily realised when one remembers that the Torpille has shown itself capable of a speed of 93 miles an hour with a 50 horse-power engine. I understand that the engine has been tested for long periods, and that the design of the machine has in no way indicated that any overheating troubles were to be feared.

The empennage is very simple, and consists of a rudder and elevator neither of which have any fixed stabilising plane in front of them and both of which are balanced and operated by cranks and pivots concealed within the fuselage. The pro-

PELLER is protected by a long skid. Simplicity is also the key-note of the landing chasis, which consists of a plain axle with a disc wheel (very thin pressed-steel discs) at each end; this axle is supported by a couple of C-shaped 'struts, each of which is

sure lateral stability in ordinary flying conditions, but as a safeguard a warping system is also provided, though this operates to only a limited extent. In the original model no *gauchissement* at all was fitted, in spite of which the monoplane showed an astonishing degree of stability.

TRAIN MONOPLANE

This is a monoplane which strongly recalls the original Santos Dumont *La Demoiselle*, although it is conceived on rather a larger plan. The general arrangement, however, is the same, the whole of the machine being centric both in plan and elevation, except the aviator, who sits immediately beneath the plane. The engine is a 50 horse-power Gnome, the covering of which is of more or less stream-like form and has its tail-piece provided by a petrol tank of conical shape. The tail plane is flat, but set at a pronouncedly positive angle. It is triangular in plan, the elevator flap being practically rectangular. A very simple instinctive control is used, the wings being warped in the usual way. The whole of the fuselage is made of steel tube and in section represents a triangle standing on its base. Wooden skids are fitted to form extensions of the lower longitudinals.

TUBAVION

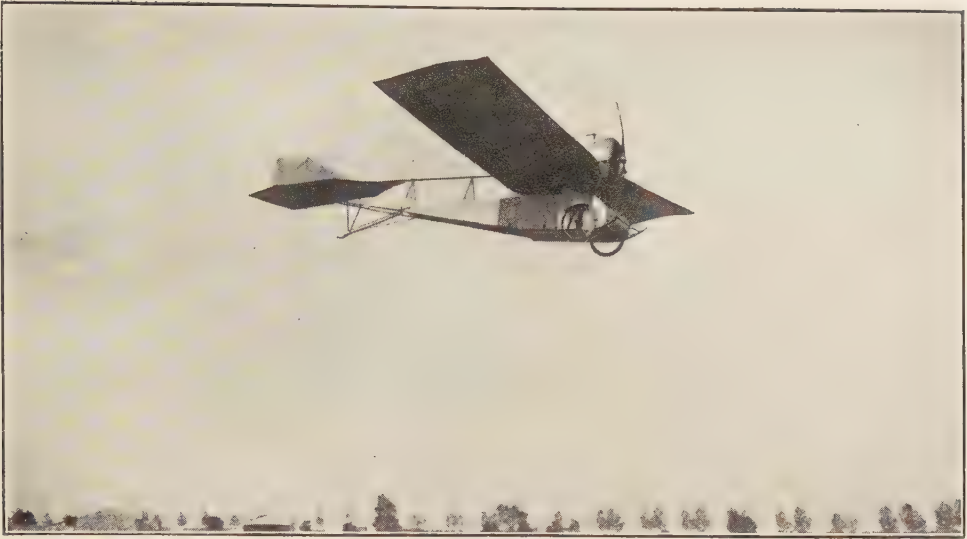
The monoplane shown by Ponche and Primard is known as the "Tubavion" by token of which it is an all-metal construction principally composed of steel tubes. The propeller is directly behind the main plane, where it is carried directly upon the long straight steel tube forming the backbone of the fuselage, there being two tensional members performing the office of skids. The engine is carried in the front of a neat two-seater automobile-type body, the transmission being by



TRAIN

pivoted in front, both in the rear being coupled up to an india-rubber shock-absorbing device. This arrangement appears to be excellent in every way, as the wheels are given long range of movement, and head resistance of the chasis is reduced.

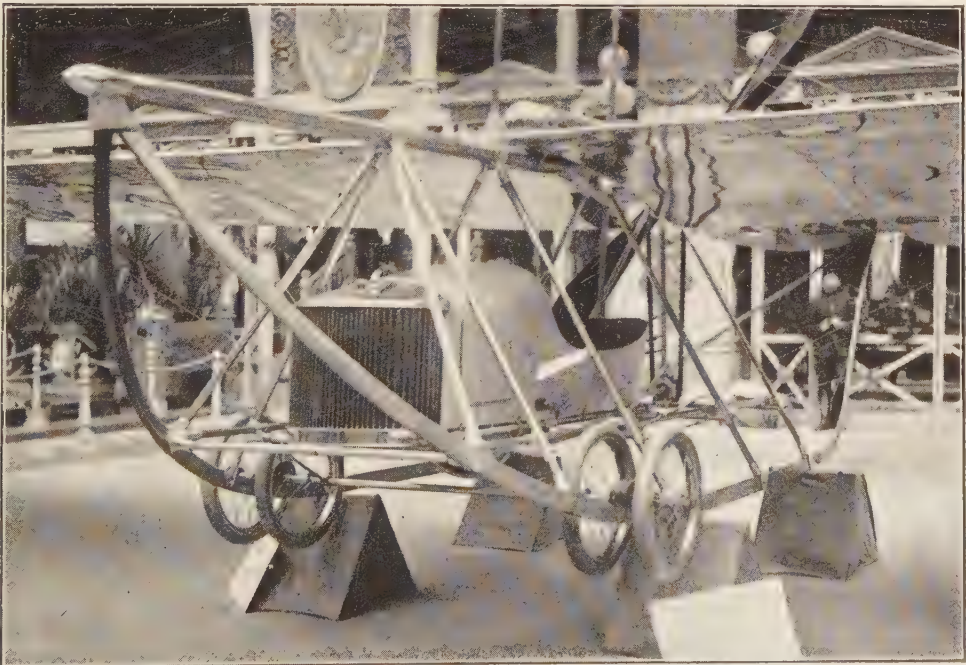
The fuselage is primarily square in section and is afterwards made duo-decagonal by a series of light wooden "formers." The shape of the wings is considered by the designers to be amply sufficient to en-



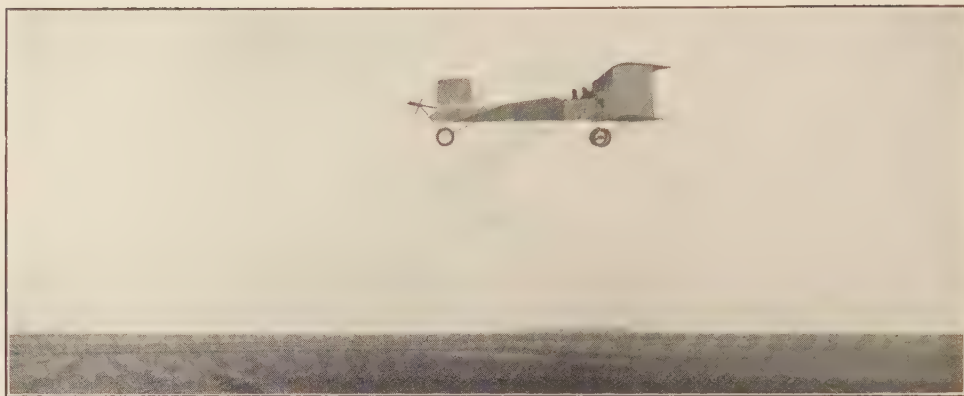
TRAIN MONOPLANE IN FLIGHT

chain with a gear reduction of 2 to 1. The centre of gravity, it will be noticed, is very low, indeed. Not the least extraordinary feature of an extraordinary machine are the wings, which are constructed of aluminium sheeting with ribs of the same material threaded upon a couple of steel

tubes, which form the main spars. The head resistance of such planes must be enormous. The rear spars are contiguous, and meet in a ring carried upon the main tube. This ring supports a vertical lever, through which the wings are warped by a rack and sector device, the



TUBAVION ALL-STEEL MONOPLANE



VOISIN CANARD IN FLIGHT

amount of warp being unusually large. The tail is a non-lifting one with a fixed plane in front of the elevator. The engine is a four-cylinder 40 horse-power Labor.

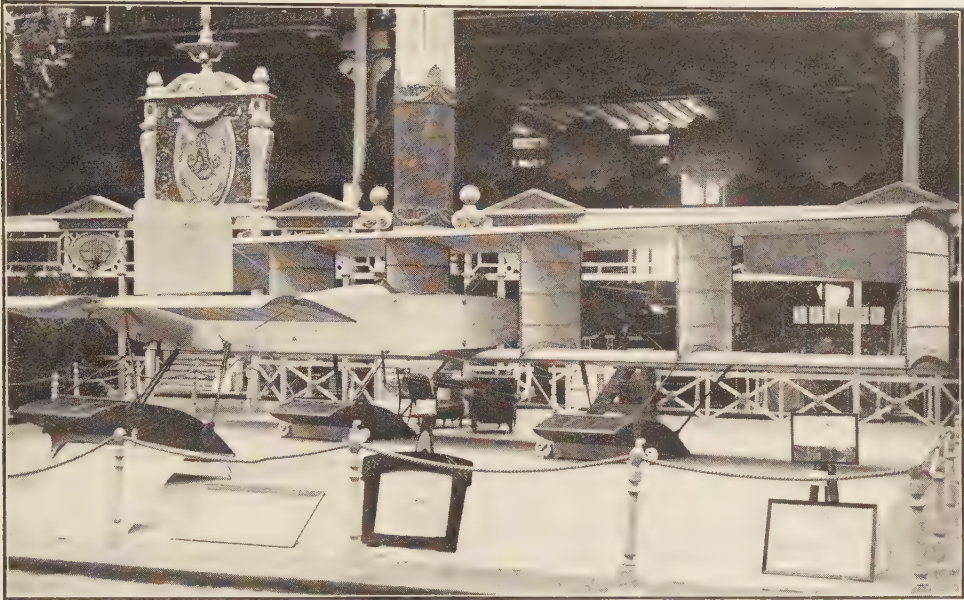
VOISIN

A hydro-aeroplane—a duplicate of that which has been so successfully used on the Seine by Colliex—is the sole model shown and is certainly a fine piece of work. The design of the machine is clearly shown in the illustration, also a view of the cock-

pit showing the pilot and passenger seat, above which may be seen the crank for starting the Gnome engine located in the rear of the plane. Another view shows the pilot and passenger in flight. Notable points are the great depth of camber of the main planes, and the fact that no fewer than six vertical panels or curtains are employed for the purpose of gaining some natural lateral stability. Another prominent point is that the fuselage, instead of being made more or less in one with the



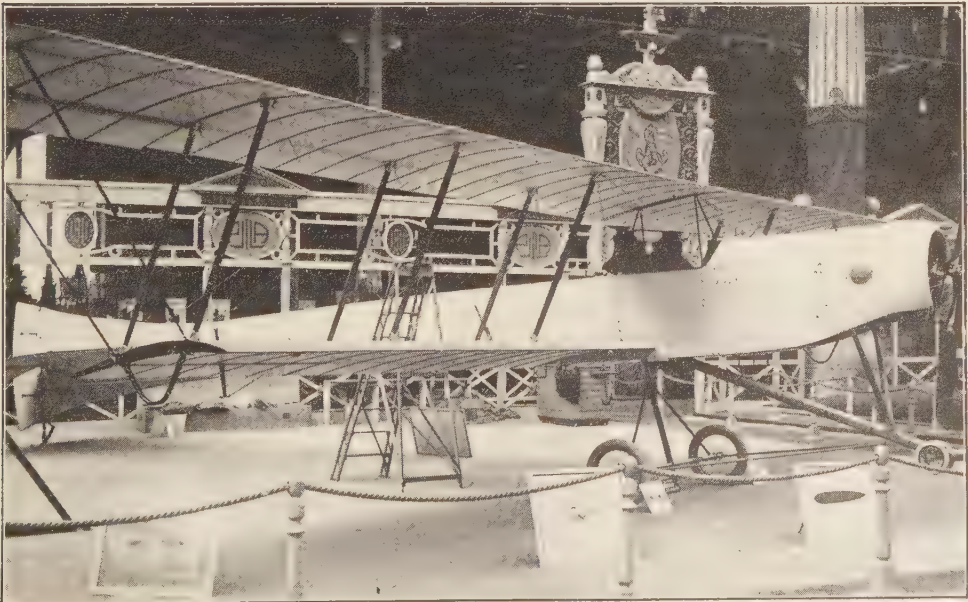
COCKPIT OF VOISIN CANARD



VOISIN CANARD HYDRO-AÉROPLANE

main cellule of the planes, is merely stiffly strung thereto with stay wires. The floats or hydro-planes are airtight chambers made of thin three-ply wood, and are sprung from the fuselage by means of a pivot in front and a jointed spring plunger rod behind. This is shown applied to the

front hydroplane, the other two being exactly similar. The biplane is of the Canard type and flies small plane first. The engine is a 50 horse-power Gnome and drives the propeller direct. Only very slight alterations are necessary in the machine to adapt it for rising from the



ZODIAC BIPLANE

ground instead of from water. Lateral control is by means of two very large ailerons let into the trailing edge of the upper plane. The hinge line of these ailerons is at an angle to the edge of the plane, so that the fixed plane may be said to taper to the tip, while (considering the aileron as part of the plane) it is rectangular. The chord of the aileron is, however, greatest at the tip.

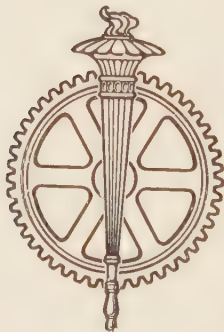
ZODIAC STAGGER BIPLANE

This firm showed a single specimen of biplane, which is of very advanced design and has already performed remarkably well. Both the length over all and the span are unusually large, the appearance of this being rather enhanced by the very high aspect ratio of the wings and the shallowness of the monoplane-type fuselage.

As shown in the illustration the planes are staggered, lateral control

being by a couple of flaps in the rear edge of the lower deck. The tail is of the non-lifting type, and both the centre of gravity and line of thrust are placed fairly high for a machine of this type. The engine is a 50 horse-power Gnome, which is mounted in a casing open in front, and at the sides and top curving over the cylinders.

It says much for the good design of this biplane that, with this engine power, it develops a speed of 60 miles per hour, and may be reckoned, therefore, one of the fastest biplanes extant. The landing chassis is more or less of Antoinette pattern. The running wheels are supported by a central steel pillar, which is attached to the fuselage with a universal joint, through which this pillar projects, the extension being provided with india-rubber shock absorbers which allow it to move to a certain extent in all directions.



COST METHODS THAT GIVE THE EXECUTIVE CONTROL OF HIS BUSINESS

VI. THE VEXING QUESTION OF EXPENSE

By Benj. A. Franklin

Mr. Franklin's purpose, as explained in introducing the first paper of the current series, is to exhibit the use and compilation of costs from the standpoint of the executive rather than that of the cost clerk. Beginning with the principles and elements that must be recognized to make a cost statement a true and instant revelation of actual conditions, he proceeds to the character of the reports that must come periodically to the manager's desk, and then to the methods by which such data can be obtained and assembled. Actual details or devices of cost collecting are discussed only so far as they are important and interesting to the executive. His topics so far have been: "The Philosophy of Costs"; "The Place of the Trial Balance in the Cost System"; "The Cost of the Salable Article"; "The Economic Consideration of Material by Costs"; and "Labor from the Cost Viewpoint."—THE EDITORS.

EVERY executive can understand the relation of material value to unit production cost, and thinks he can control it. Its application is direct. Every executive can appreciate the application of labor charge to article cost, even if he has not developed methods that control it. But when the vexing question of expense arises there is a variety of opinion as to its application to unit costs. Who shall devise a non-disputable way to apply the salaries of the executive organization, for instance, as an item of expense to each unit of production, when many of the units it may never think of, and others may be the source of much time and expenditure?

And certainly, to most executives, expense, as an element struggling against control, is, to say the least, a matter of constant anxiety. The consideration of expense as a cost item, then, has to do with two main points:—

1.—Its relation to the cost of the salable article.

2.—The control of the expenses of the factory through proper presentation of the running facts of operation.

Much has been and will yet be

written on this first point, and a number of different theories as to the proper method of expense application have been advanced.

Thus, we have theories of expense addition in proportion to units of weight or measures [the most common one], to material cost, to material and labor cost, to labor cost, to the labor hour, to the machine hour, or to various combinations of these bases. And it cannot be denied that there are cases where each theory seems most suitable.

That there are so many theories is, possibly, not a little due to the fact that there is no positively right one, but nevertheless the necessity for theory exists. But the theory must be a practical one.

Now, the statement that there is no theoretically right way to add expense to a particular unit cost must be modified somewhat, because a clear understanding of this element of cost, and its use, lies not merely at the bottom of the proper conception and use of a cost system, but, on account of the necessary changes in expense due to any change in management methods, it lies more importantly at the base of proper comprehension of the principles of factory

operation, of the meaning and value of modern methods, and of the struggle for efficiency; and it is a crucial element of profit making.

It is not to be understood by this statement, then, that there are not many items of expense which are clearly, and in measureable amounts, chargeable to the production of some particular article, since they may be due to such production; or that there are not many expenses which may be fairly chargeable to each article of manufacture in certain calculable amounts, or along certain reasonable lines, though general to the whole production. There are direct expenses and others not so direct, which, nevertheless, by varying and evident theories, can and should be directly applied. But there are many and large items of expense necessary to the whole production, however it may vary, which touch the production of any particular article in no direct manner, which do not vary with production in any close degree, and which resist all attempts to be handled as direct items of cost like labor and material. These expenses are indirect. They have distinctly to do with the whole production, without having a readily measureable relation to the unit.

It is to meet this condition that theories are devised. Each theory advanced will be valiantly upheld by those who feel they have reasoned the matter out. But it must be remembered that it is generally a failing of the formation of theories in relation to complicated conditions, that, once the basic theory is established from one main fact, all other facts are made to fit around it. We constantly see this illustrated, in our own theories of government, of which the tariff has long been a notable instance.

Now, in forming a theory of ex-

pense application, there are two elements to be taken into consideration with which expenses vary, even if in no absolutely measureable degree, viz:—

1.—Time, or the labor hours of factory operation.

2.—Condition of operation, or the physical and mechanical conditions surrounding each operation.

It is very apparent there are many expenses which vary with time, by the month, week, or hour, such as salaries, rent, indirect-labor costs, etc.

It is equally apparent that there are other expenses which vary not only with time, but also with condition of operation. No great argument, for instance, is needed to show that it is more expensive per hour's work done on a heavy machine requiring much power, costly upkeep, expensive tools, etc., than on a small one, and that the conditions of operation make the difference.

Operating, then, with these two measures of variation, it is possible to apply all expenses to units of production. But in any plant of size there is a large variety of conditions of operation and numerous items of expense having apparently somewhat different bearings. It is, therefore, necessary to form some basis of relation, some channels of flow, some theory of application and visualization of expenses, that will permit the executive to bring order, direction, and control, out of a heterogeneous group.

The old and simple way of dividing total expense by total production will no longer give sufficiently close costs. Except in very few plants manufacturing a uniform product, it no longer suits modern conditions of competition; and to work out figures for each condition of operation (which in many plants, if carried out in detail, might mean a different figure

for almost every operation) presents a task almost too large for the ordinarily obtainable talent.

A midway solution, then, seems desirable, but the theory adopted must be one which leads to the most practical results in the long run, for costs, to be valuable, must render practical value. In arriving at a solution certain facts and conditions should be considered.

When the subject of costs meets the consideration of most executives, they think only of its value as leading to knowledge of the cost of the salable article. This is, of course, a very important point and if it were the only point and absolutely gauged selling price, then much detail, if it led to truer cost, need not be feared. But in actual good practice the second point, control of expense, comes to be of prime importance after the first knowledge of cost of articles has been obtained, absorbed, and used as best it may. Therefore any theory of expense addition that does not take this necessity into account, does not thoroughly fit the case.

For expense is a factory disease and an insidious one. It is not meant by this that expense may not profitably be large, or that profits may not, under proper conditions, be increased by increasing expense ratio. Scientific management is a definite preachment that this is so, and the average factory common sense is learning that money spent in studying operations, and in making complete arrangements for their fulfillment, is an expense that is most often much more than made up by reduction in other costs. But just as the human system is full of microbes, well balanced in health and presumably an essential part of existence, but liable under adverse circumstances to break out to the disadvantage of the container, so it is with the factory sys-

tem and expense; which latter, because of varying judgments, misplaced efforts, or thoughtless management, has a constant tendency to unprofitable excess.

The executive, like the Chinese doctor, desiring to keep his plant healthy rather than to cure it when sick, should have his expenses so displayed in relation to the running situation as to be always able to control them. But in accomplishing this there must, of course, be kept in mind the necessity of arriving at an article cost which is approximately fair and true as a basis for meeting competition.

Now the cost problem, while it has to do with figures, is not a true mathematical problem in the sense that there is but one practical answer under given conditions. Cost is not a matter of figures; it is a matter of ideas, of which figures are only the suggesting elements. There can be only an approximately true and fair cost of an individual article obtained even though the cost of total production is mathematically exact, which leads us into some discussion of expense, the constant mutations of cost, and the fixing of selling prices.

Certain expenses are spoken of as fixed expenses, but they seldom remain fixed over any long period. There is a constant attempt to make production vary—generally to make it increase. The loudest cry of the factory executive is for production increase with the very intention of varying the unit expense cost—downward of course—though this cry is often checked by public demand or other conditions. The successful effort finds its result in keeping the relation of these two variants, or the percent of expense, within planned limits, or constantly downward in trend.

It must be constantly borne in mind, in forming a theory of expense appli-

cation, that, in the final analysis, total expense applies strictly to total production, and, without changing the particular conditions of operation, the expense cost per unit of production may vary very remarkably from time to time. For instance, in dull times, though there may be absolutely no change in particular conditions of operation, the expense cost per unit takes a swift upward trend. It is to prevent this that, in such periods, our manufacturers sell very cheaply abroad, if not at home.

And this leads to the fact that when discovery of net losses in certain articles is made it does not always increase total profits to discontinue their manufacture. It may frequently decrease profits to cut out losing articles unless their place in the total production is taken by profit makers. This will always be so where the loss on an article is less than the general expense burden it bears, for, whereas the rest of the manufacture only has to carry the loss in one case, if the article is dropped the remaining articles have to carry the greater burden of expense. Of course unprofitable articles should be dropped (providing the cost cannot be sufficiently reduced) if they can be replaced by other profitable ones. But the question of final profit has always to do with total production and its relation to total expense, and the practical theory of expense application and showing must deal with this question.

There is no such thing as an absolute or fixed unit cost. Even if the material cost of a given article did not vary in different lots, (and it does, because of variations in waste per cent if not in base cost) and if labor costs did not vary (as it does in most factories)—nevertheless, since the total expense must be divided over total production, and since these two are constant variants, yet

seldom varying together, it follows that expense cost per unit is constantly varying.

It is also a fact, that, except in the case of monopolies or special articles, and frequently even in their case, the price is fixed by competition, or a figure that will stimulate demand, and not by the cost of the article in any particular plant. As a matter of fact the selling price often fixes the cost, since many an article is definitely made to sell at a prefixed figure and the costs are arranged accordingly, and where cost has been the basis of the selling price it has generally been a cost roughly estimated and not scientifically worked out. The main value in the knowledge of unit cost in most plants is not to fix the selling price, then, but to lead to methods of cost reduction and control. So that in the interest of the attainment of an expense showing which will give the executive a grip on it, there may be safely sacrificed some of the effort to get an apparently closer cost by figuring too finely the expense cost of individual conditions of operation.

Furthermore the human element enters somewhat into this problem. The executive mind demands methods simple and easy to follow, methods that make comparisons over periods of time fairly easy, and particularly methods that show quickly the reasons of changes for the better or worse. Add to this the further fact, that for continued life it is essential in most plants that the cost system be one not subject to constant readjustments on account of slight changes in conditions of operation, on account of the undesirability of the amount of calculations that would be necessary, the failure on the part of the cost force to appreciate the changes, and the spoiling of comparisons with constant readjustment.

Let us see, then, in brief recapitulation, what are the elements to consider in forming a theory of expense application and showing. It will appear to the practical man that there exists the following conditions, which must be taken account of, viz:

That in addition to certain expenses that have a direct application to the cost of the articles of manufacture, there is a large floating expense due to the existence of the business and the policies adopted, which applies, not to particular articles but to the whole production, but which does not vary as it.

That with expense added, the final cost of an article must vary, and can only be approximately fair and true.

That while selling price, for profit, must average higher than cost, nevertheless exactly attained cost has never been the basis of fixing selling price, and that even individual unit cost has its greatest value as a basis of cost reduction and control.

That total plant profit is made only as a result of the total production, interlaced so to speak; and that changes in the line of articles produced based on article cost as a guide, will not produce the mathematical result in plant profit the unit cost would seem to indicate, and that consequently expense, which causes this vagary, must be shown in some clear relation to production, or some kindred indicative element, so that changes in production will immediately reflect themselves in changes in expense ratio, increased production showing decreased ratio, and decreased production causing increased ratio.

That it is essential to make such showing of expense and its application as will offer the executive characteristic and comparative views of it, as a means of control, and that a main value of costs is to present pic-

tures of events, in order that imperfect service may be discovered and remedies provided. Costs, of value, must be presented by a method which is a quick tattle tale.

That comparisons are essential, and the methods used must offer them—covering the general situation, even if slurring some minor changes.

That to have continued existence the cost system must be simple, simply kept up, and readily understandable.

That expenses tend to vary according to two main elements, time and condition of operation, and these must form the basis of expense application. It must be remembered, however, that, while expenses tend to vary as these elements, in the case of very many expenses it is only a tendency and not an absolute ratio.

Working, then, from these conditions and necessities, it is not difficult to arrange the expenses according to like groups of conditions of operation, and show them in this arrangement in relation to the time of their use in given periods, preferably by weeks or months. Such groups, in most factories will develop into classification by departments, or divisions thereof, as the conditions of operation may vary in the departments, and, of course, may be made in what detail the executive desires. But he will generally be wise not to make such divisions too fine.

Under such a plan there readily occur groupings of such like conditions of operation as general expense, department expense, department division (where conditions are radically different) and selling expense. But before these are arrived at there must be a grouping of certain miscellaneous conditions of operation, as depreciation, taxes, insurance, power, repair, etc., and a dispersion of their totals among the other groups, (here

Depreciation, Taxes, Insurance		EXPENSE ANALYSIS	(Form 13)
		Year	
Depreciation		\$12,000.00	
Taxes		4,000.00	
Insurance		2,800.00	
Year		\$18,800.00	
Month		\$1,566.67	
Dept. 1.....	10%	\$156.66	
“ 2.....	10%	156.66	
“ 3.....	50%	783.34	
“ 4.....	20%	313.34	
Power, Heat, Light.....	10%	156.67	
		\$1,566.67	

after to be called departments) in proportion to their average or particular use in those departments.

It may be further said here that even after such divisions are made there are certain expenses which have to do, not with time or condition, but with other units. These expenses are very apparent in their application, however, and should be separately so shown.

Forms 13, 14, 15, 16, 17, 18 and 19 illustrated this method of expense analysis.

The period chosen may be either of the week or month—by the week preferably—until expense is under good control—and its application analyzed and understood. If kept by the month, however, this method resolves itself into a very simple affair.

It may be well to say here that under such a plan of expense analysis the use of the “Voucher Register,” Form 20, offers a very simple arrival. This book, as will be seen, is an entry book for all money spent whatsoever. Under the column “Expense,” go all

POWER, HEAT AND LIGHT—EXPENSE ANALYSIS					(Form 14)
	April, 1912—4 Weeks		May, 1912—4 Weeks		
	Month	Period to Date	Month	Period to Date	
Engineers	214.00	843.11	221.60	1,064.71	
Firemen and Helpers.....	365.80	1,452.10	362.52	1,814.62	
Coal	1,998.70	10,000.11	1,930.00	11,930.11	
Electrical Supplies	10.20	32.15	32.00	64.15	
SUPPLIES					
Shovels	1.80	3.60	.92	4.52	
Barrows	0.00	0.00	17.80	17.80	
Oil	31.06	148.16	28.11	176.27	
Repair Labor.....	160.00	242.00	46.14	288.14	
REPAIR MATERIAL					
Boiler Repair Parts.....	82.60	104.30	44.80	149.10	Etc.
Engine Repair PaPrts.....	85.56	408.00	6.17	414.17	
Gaskets		0.00	3.26	3.26	
Packing		0.00	.42	.42	
Miscellaneous	12.36	59.60	5.12	64.72	
Depreciation, Taxes and Insur.	156.67	626.68	156.67	783.35	
Total	3,118.75	13,919.81	2,855.53	16,775.34	
Distribution—Based on average H. P. used.					
Department					
1, 19%.....	592.56	2,644.76	542.55	3,187.31	
2, 11%.....	333.06	1,431.18	334.10	1,765.28	
3, 47%.....	1,465.81	6,542.31	1,342.09	7,884.40	
4, 23%.....	727.32	3,301.56	636.79	3,938.35	
100%.....	\$118.75	13,919.81	2,855.53	16,775.34	

such items so chargeable which may find their analysis under the column "Explanation," in whatever detail may be desirable to make up the analysis at the end of the week or month, the totals of which must agree with the totals of the "Voucher Register" and consequently with the one ledger account "Expense" which this method permits. By such a method it is no great task to make up an expense analysis in a short time, each month, even if there be fifty or more departments.

because almost all the details of expense will bear much consideration. It may be said, briefly, that a conservative depreciation would be 10 per cent on machinery and equipment, and 2½ to 5 per cent on buildings, although, for those who desire or feel the necessity for detail, each unit of investment may be depreciated separately and according to experience or estimate. Depreciation, taxes, and insurance are apportioned to the departments according to investment therein.

REPAIRS		EXPENSE ANALYSIS		(FORM 15)	
Labor	April, 1912— Month	4 Weeks Period to Date	May, 1912— Month	4 Weeks Period to Date	Etc.
Foreman	84.00	330.00	84.00	414.00	
Millwrights	173.98	318.20	96.11	414.31	
Machinist	97.65	349.65	84.00	433.65	
Pipers	53.14	193.16	61.80	254.96	
Mason	14.00	43.25	0.00	43.25	
Carpenters	48.00	161.16	56.45	217.61	
Painter	47.50	164.11	0.00	164.11	
Outside Labor	18.00	33.00	12.00	45.00	
Miscellaneous	6.00	10.00	3.00	13.00	
Total Labor	542.27	1,602.53	397.36	1,999.89	
MATERIAL					
Machine Repair Parts.....	441.06	1,050.42	94.30	1,144.72	Etc.
Pipe and Fittings.....	18.13	108.13	241.60	319.73	
Electrical Supplies	16.00	39.08	8.18	47.26	
Belts and Belting Supplies....	110.66	243.50	24.60	298.10	
Lumber	47.16	129.18	18.03	147.21	
Glass	0.00	18.06	0.00	18.06	
Paint	74.00	165.02	0.00	165.02	
Bricks	0.00	0.00	0.00	0.00	
Cement	140.94	506.70	0.00	506.70	
Nails, Bolts, etc.	4.30	28.67	3.92	32.59	
Total Material	852.25	2,288.76	390.63	2,679.39	
Total Repair Cost.....	1,394.52	3,891.29	787.99	4,679.28	
[Distribution according to use]					
Dept. 1.....	416.19	1,308.62	176.76	1,485.38	
" 2.....	23.11	123.82	89.60	213.42	
" 3.....	79.58	690.06	243.80	933.86	
" 4.....	22.94	74.03	18.60	92.63	
Power, Heat and Light.....	340.52	813.90	105.91	919.81	
General	512.18	880.86	153.32	1,034.18	
	Month	Date	Month	Date	

Period figures should be entered in red to distinguish them quickly from figures of the month.

It may not be needless to give, here, some slight description of these forms and their application.

Form 13 shows a division of depreciation, taxes, and insurance among the different departments. It is not the purpose here to go into lengthy discussions of certain details,

Form 14 shows the details and totals of power cost, and its division between the departments in proportion to average use.

Form 15 shows the details of repair cost and its apportionment to the different departments according to the actual expenditures in them.

GENERAL EXPENSE		EXPENSE ANALYSIS		(FORM 16)	
Previous 3 Years 12½, 13½, 14 cts.		April, 1912—4 Weeks		May, 1912—4 Weeks	
	Month	Period to Date	Month	Period to Date	
Office Salaries	2,500.00	10,000.00	2,500.00	12,500.00	
" Stationery	93.08	93.08	0.00	93.08	
" Supplies	0.00	61.19	13.50	74.69	
Telephone	30.00	100.00	71.50	171.50	
Incoming Express	43.18	124.99	22.11	147.10	
" Freight	340.00	582.01	59.16	641.17	
Trucking	118.30	333.96	106.11	440.07	
Watching	81.00	325.80	81.00	406.80	Etc.
Miscellaneous General Labor...	135.09	510.40	107.62	618.02	
Miscellaneous General Supplies	283.42	711.14	146.11	857.25	
General Repair Labor.....	250.00	504.11	103.06	607.17	
" " Materials	262.18	376.75	50.26	427.01	
Pensions, Insurance, etc.....	902.80	1,152.40	508.80	1,661.20	
Donations	75.00	75.00		75.00	
Legal Expense	200.00	800.00		800.00	
Total General Expense.....	5,314.05	15,750.83	3,769.23	19,520.06	
Total Direct Hours.....	32,640.00	106,013.00	31,876.00	42,488.00	
Cost per Hour.....	16¼ cts.	15 cts.	12¼ cts.	14¼ cts.	

DEPARTMENT No. 1		EXPENSE ANALYSIS		(FORM 17)	
Previous 3 yrs. 35, 36, 34 cts.		April, 1912—4 Weeks		May, 1912—4 Weeks	
	Month	Period to Date	Month	Period to Date	Etc.
Foremen	196.00	784.00	196.00	980.00	
Inspectors	120.00	486.60	123.60	610.20	
Miscellaneous Labor.....	148.60	532.07	83.49	615.56	
Repair Labor.....	164.11	469.99	93.08	563.07	
REPAIR MATERIAL:					
Belts	31.40	59.06	3.42	62.48	Etc.
Machine Parts.....	142.10	583.00	64.18	647.18	
Room Repairs	78.58	196.57	16.08	212.65	
SUPPLIES:					
Oils	116.95	121.95	2.15	124.10	
Miscellaneous	198.34	201.12	3.12	204.24	
Total Controllable Expense	1,196.08	3,434.36	585.12	4,019.48	
Power, Heat and Light.....	592.56	2,644.76	542.55	3,187.31	
Depreciation, Taxes and Ins...	156.66	626.64	156.66	783.30	
Total Expense.....	1,945.30	6,705.76	1,284.33	7,990.09	
Direct Labor, Hrs.....	5,836	23,560	5,561	29,121	
Cost per Hr.....	33½ cts.	28½ cts.	23½ cts.	28½ cts.	
or					
Direct Labor.....	1,459.13	5,890.00	1,370.48	7,260.48	
Per Cent Expense.....	133%	114%	94%	114%	

Period figures should be entered in red to distinguish them quickly from figures of the month.

Form 16 shows the general expenses.

Form 17 shows the department expenses with their additions from other departments. There will, of course, be as many of these showings, in the expense analysis, as there are departments or divisions made to cover the productive portion of the plant. The expense of the department is totaled first to a "Controllable Expense," this being the amount

occurable in the department, and so under the control and supervision of the foreman.

Now, in all these Forms which, complete, give an analysis of expenses, there is to be noted that, month after month, the expenses, in all detail desirable, are shown comparatively, and likewise the additions of the same to date from a given start, generally the first of the year or inventory time, these latter addi-

tions being known as period-expenses. Any increase or decrease can be immediately noted.

In addition, the relation of the expenses is shown to the running productive situation. This is expressed, preferably, as a cost per productive or direct-labor hour, such hours of each department being kept for each month and an expense cost per hour worked out. But in departments where the work is similar and the wages of employees practically alike, it is as effective to show the relation of expenses to the direct or productive labor. Both methods are illustrated. Thus, with such a constant and easily readable showing of expense and its relations to the running production in all the different departments, the executive has an opportunity to study expense, to experiment with it, and to control it.

But to make it as easy as possible, Form 19 is added. This form is a synopsis of the whole situation, showing first the index figure for the plant, and then the index figures for the departments with plant index

figures for previous years. Through this the executive can put his finger on the weak spot, monthly, without poring over the whole situation, and in a very short time can compare the plant situations with previous periods. In this particular form the expense is shown in relation to direct labor, but can easily be shown in relation to productive or direct-labor hour.

As will be seen, expense cost as applied to an article varies as labor cost or labor time. This is an important fact, for if the time of labor operations can be shortened, the expense cost as well is reduced, and with proper means of assuring himself of the facts, the executive can afford to increase such expense as is caused by the study, preparation for, and assistance to labor, with the idea of reducing operation time, knowing that he can readily discover quickly the total cost-labor and expense—and compare it with previous conditions.

Form 18 gives selling expense, which is shown in relation to sales, or indicating the number of cents it

SELLING AND ADVERTISING		EXPENSE ANALYSIS		(FORM 18)	
Previous 3 Years 10, 9, 9½%	April, 1912—4 Weeks		May, 1912—4 Weeks		Etc.
	Month	Period to Date	Month	Period to Date	
Salesmen's Salaries	1,500.00	6,000.00	1,500.00	7,500.00	
Traveling Expenses	373.16	1,115.16	291.14	1,406.30	
Postage	125.97	395.20	43.00	438.20	
Telegrams	14.18	42.20	6.20	48.40	
Express	42.26	153.19	15.13	168.32	
Freight	464.16	1,026.18	432.00	1,458.18	
Miscellaneous	93.18	270.91	75.62	346.53	
Cash Discounts					
Bad Debts	118.12	138.12	0.00	138.12	
Catalogues	468.00	675.26	0.00	675.26	Etc.
Samples	58.17	216.90	24.93	241.83	
Magazine Ads.....	1,420.00	5,680.00	1,420.00	7,100.00	
Newspaper Ads.....	1,230.00	2,059.00	900.00	2,959.00	
Total Expense.....	5,907.20	17,772.12	4,708.02	22,480.14	
Total Sales.....	65,635.63	207,966.48	59,654.80	267,621.28	Etc.
Percent Expenses to Sales.	9.	8.5	7.9	8.4	

Period figures should be entered in red to distinguish them quickly from figures of the month.

EXPENSE ANALYSIS

(FORM 19)

Period figures (shown in this Form in heavy-faced type) should be entered in red to distinguish them quickly from the figures of the month.

takes to sell a dollar's worth of goods. Here, it will be observed, are added cash discounts taken by customers, and bad debts. The selling may be departmentized where there exist definite divisions, and the advertising may be shown in relation to particular articles, or classes.

As will be seen in Form 4 (see previous article), expense is added on unit production cost, when labor time or cost is known, first as a charge per total hours for general expense, followed by a charge per productive or direct-labor hour in each department, or as a per cent on direct labor, as the choice may be. Selling expense being added, the complete tale of expense, in its relation to the salable article, is told.

There may be disputes as to whether sundry items should be put into expense and the practice is varied in this matter. A good practical basis of operation, however, in these matters, is that costs should be made as high as they legitimately can, and that the difference between cost and selling price, if a profit, should be a final one from which is to be deducted not even contingencies. Human nature needs the spur of necessity to make improvements and a high cost is a valid incentive to action in that direction. Depreciation, and a high one, on tools and apparatus liable to change, losses on material when they cannot be charged to an article of manufacture, samples, cash discounts, bad debts, and, under some circumstances, interest, and in fact every charge which does not belong to the material or labor costs, should be put into costs. It is healthy cost where the dollar of profit can be placed in the bank.

The method outlined is not a new theory. It has been in very successful practice for at least eight or ten years, and is now in operation in some one hundred or more plants.

The philosophy of cost has nowhere a more important bearing than in dealing with the expense analysis.

Practical accuracy, it is very plain, is the only term that could be applied to expense application under any form of analysis, but under this form it is easily apparent that the totals can readily be made accurate to the penny.

The indirectness of its application, the constant pressure for its increase, inability to control it except by extreme watchfulness, makes imagination to visualize expense in its effect and final result and value, a very essential element for executive use. With the use, however, of the forms of expense analysis illustrated, the department, from the expense point of view, looms up clearly with its condition shown from month to month, and period to period, and its relation to the productive situation. And it takes a hard-headed imagination to visualize the future with sufficient confidence to increase expense in an attempt to reduce wastes and labor cost of operation. Yet to double expense cost per hour, if labor operation cost can be cut in two, is to reduce cost, not to mention possibilities of waste saving.

Here, then, steps in the practical instinct which, with the shrewd use of imagination, traces the probable effect of expense action, and renders the profitable decision, whether it be to spend or restrict.

Standards are somewhat difficult to form in expenses, and are necessarily varying as policies and conditions change. They can and should be made, however, and be given to those who may have some control of expense.

Comparisons are, of course, of vital necessity.

Without arrangement no executive could follow the intricate course of a mass of expenses and rightly inter-

(FORM 20)

(FORM 20)

pret their effects, but with such an arrangement as this expense analysis, starting with Form 19, the executive can pass quickly over the whole situation, concentrating his attention on the departments and expenses needing it most. Through such arrangement the alert executive can keep very close touch on the situation.

In the matter of periodicity expense analysis may be made weekly at the close of the payroll, and from the point of close contact with it and regularity, there are advantages in this period. It will ordinarily be shown by the month as simpler to make up.

Co-operation of the executive organization finds no better field for action than in studying the expense analysis and assisting in the effectiveness of expense. They are, indeed, a part of it, and much of it depends on their force, executive ability, and arrangement of affairs. They should then be let into its secrets. They should be shown its effects and results.

It may be said finally that in competitive businesses it is more important that the theories of expense application should be alike, than that they should be exact, except in totals, and under any theory it is essential that expense include every proper item. It is a mistake that many executives make to class certain items,

liable to quick disappearance or obsolescence, as assets. While it may make book profit appear larger, it makes actual profits no larger. These two points were the bases of the standard cost system adopted by the National Association of Machine Tool Builders, which I devised.

Expense is distinctly the tool of the executive. Material use comes naturally from the design. Labor is essential in all cases to its shaping. But expense is the instrument with which the executive shapes his factory course, his weapon in fighting the battle of profit. There are rules for its use, but they are not readily discernible except by experiment, nor readily workable except with the use of thought, patience and persistence. Closeness in expenditure, low expense ratio, may, according to circumstances, mean eventual dry-rot or safe profit. Liberality in expense may, according to the conditions of it, mean eventual ruin, or increase of profits. There is always a certain amount of expense that is absolutely necessary to the existence of the factory organization, and it is true that any other item of expense is wisely made when it fulfils a definite purpose that leads to an economy eventually greater than the expenditure; and a clear knowledge of expense and its relation to production is essential to such calculation.



SAFEGUARDING LIFE AND PROPERTY AT SEA

CONSTRUCTIVE SUGGESTIONS FOR AN INTERNATIONAL MARINE CONFERENCE

By George A. Soper

Captain Hobson, with the characteristic directness of the seaman and naval constructor, takes up the physical facts and forces concerned in the loss of the "Titanic" and proposes specific physical measures of betterment. Dr. Soper, with no less characteristic grasp of economic, sociological and legal influences, attacks the problem of providing institutions by which the proper reforms, of whatever kind, may be made effective after they have been determined. The views look at the subject from opposite sides; yet they are not opposed, but thoroughly harmonious and mutually supplementary.—THE EDITORS.

THE investigation into the sinking of the "Titanic," which has just been made by the United States Senate, and the one which is being carried on by the British Government, will be of little use if they are not followed by wise action to increase the safety of life and property at sea. Of far more importance than the fixing of blame, if blame indeed is responsible for the terrible catastrophe, will be the adoption of such measures as will make life as safe on the ocean as the progress of science and invention gives the public a right to expect.

Two steps must be taken to accomplish the desired result: First, it will be necessary to decide upon the precautions to be taken; and, second, means must be found to make certain that the precautions will be followed intelligently, continually, and effectively.

At the present time, it is by no means clear what steps should be taken to make life and property at sea as safe as it can reasonably be made.

A life preserver and a seat in a boat for every man, woman and child seem obviously desirable, but this is not enough. The aim should be to prevent the necessity for using these last desperate measures. They

do not afford the security which they are commonly supposed to insure. The condition of the sea will not often permit a boat to be launched from the deck of a steamship into the water 50 to 75 feet below. A human being cannot live long supported by a life belt in mid-ocean. It was only through the remarkable coincidence of a calm sea, absence of panic, and prompt rescue that so many passengers were saved as escaped death when the "Titanic" sank. Not less remarkable than the sinking of the ship was the survival of any of its passengers.

There is a firm public opinion that the collision should have been prevented. To have avoided the proximity of the ice would have prevented it. But this would have carried what was believed to be an unsinkable ship by a long detour on its maiden voyage while the people of two continents looked surprisedly on. Delay in arrival would have brought criticism of the captain, not to speak of distrust in the ship. Why take such precautions—were vessels not passing through this region every day without accident? Custom and statistics appeared to justify the risk. Hundreds of voyages had been made by this route at this season of year, sometimes with the ice extending

much further south than it did on April 15, 1912, and without harm. For a generation half a million people a year had passed through this part of the Atlantic without the slightest mishap. Continued immunity from accident and the arrival of steamships with the punctuality of railroads had led to the opinion that the danger was negligible. If the particular iceberg which sank the "Titanic" had not chanced to lie undiscovered in the very path of the ship on that fatal night, the world today would be applauding the speed, luxury and reliability of the vessel and her owners would have begun to reap the usual reward of alert business enterprise.

The demand that there shall be no accidents whatever at sea places a unique burden upon ship owners, for it requires that the element of chance, so invariable in most other commercial ventures, shall be utterly eliminated. It is equivalent to requiring that the death rate shall be zero, a result which is accomplished under no other circumstances. It is probable that this requirement cannot wholly be met and that to approach it excessive care must be taken both to avoid accident and to insure escape in those rare cases in which the preventive measures prove ineffectual.

The scope of the precautions that should be taken to assure the most perfect security to life and property at sea which it is possible to provide is exceedingly broad and involves many problems, some of which are of a highly technical nature. The precautions have to do with navigation, with ship construction, with the size, character and discipline of crews, with the form and use of apparatus, and perhaps with the organization of an international board capable of making regulations and insisting

upon a strict compliance with them. These matters cannot be settled at once. Time is required for their consideration. The measures which now seem most desirable may not by any means be the best. It would be deplorable if this greatest of sea tragedies should lead to nothing more than a mass of impracticable suggestions and inoperative laws. Cool councils should prevail, and the strong natural feelings which the horrors of the "Titanic's" doom have aroused should be kept from expressing themselves in hasty legislation. There should be action, immediate action; but immediate action does not mean immediate legislation. It means immediate concentration upon the solution of the economic, legal, political and professional problems involved, so that action may be taken along sane and sober lines, so that the best possible precautions can be devised and, when once decided upon, carried rigorously into effect.

A suitable means of deciding upon the precautions which should be adopted, as well as of devising ways of insuring their employment, would be through an international marine conference called under the authority of the United States Government in accordance with an act of Congress. The conference should be given a sufficient time, presumably some months, for deliberation, and an adequate sum of money should be appropriated to meet its expenses and the publication of a full report with recommendations. A programme for the conference should be prepared long enough in advance to permit the accredited delegates of the various Governments to prepare themselves especially for the discussions in which they are expected to take part. It is desirable that the number of official delegates should be at least three from each country, and that the votes cast

should be in proportion, not of the ships sailing beneath the respective flags, but of the number of passengers and value of commerce entering and clearing the ports of the respective nations. No one can doubt that every important maritime power would gladly accept this invitation if it could be extended now.

The conference should report to the Congress and President of the United States and the recommendations arrived at should be made the subject of international agreement, in so far as the laws of the various countries could be made to secure the desired ends. In other instances, as, for example, if it was thought necessary to insist upon ships following definite courses at sea, some other means of enforcement could be devised. The best way to make the recommendations of the conference effective might lie in the establishment of an international oceanic police. It would appear that the duties of this body might appropriately include the enforcement of provisions for the safety of life and property on ship-board, the maintenance of a patrol of the most frequented ocean routes, the collection and transmission of facts relative to the location of ice, derelicts and other obstacles to navigation, the making of weather observations and transmission of the same to ships, the supervision and exchange of wireless and other messages, the investigation of the causes of wrecks, the making of experimental tests of apparatus designed to afford greater security to life and property at sea, and the relief of vessels in distress.

If an oceanic police seems impracticable, and no other form of international compulsion can be devised, it is possible that the adoption of the recommendations of the conference could be attained through amendments to the laws of the various

countries under which life and property on the high seas are insured. It is reasonable to suppose that those who insure lives, vessels, and cargoes may compel compliance with such provisions for safety as are, in their judgment, necessary, by discriminating rates and by refusing to pay losses in case the specifications of the insurance policies are not complied with.

Contrary to general supposition, there is now no central authority with power to change any lane or route across the seas, to compel ships to go slowly in fog, to modify or enforce the so-called rules of the road, or to compel the use or disuse of any signal system or life-saving device. Usage on the deep seas is merely a matter of agreement between ship owners in their mutual interest, and compliance with the laws of the country under which the ship sails is all that is demanded in a legal way. Such regulations as are observed beyond the legal requirements of the several countries are the outcome of rules laid down for English ships by the British Board of Trade in 1862, subsequently revised and still further modified as the result of a conference of delegates of the maritime powers, held in the United States in 1889.

Since the conference of 1889, the development of methods of saving life and property at sea has stood still. At present, much of the apparatus in use, including the form of lifeboats and methods of launching them, are lamentably out of date. Even the sailors upon whose skill a large part of the safety of the old-fashioned lifeboat depended have passed away and their places are taken by crews which rarely have occasion to handle a rope or lift an oar. The invention of wireless telegraphy, the employment of gasoline as a motive power, and the use of search-

lights, together with the improvements possible through the use of steel in place of wood, suggest that life-saving methods and the construction of vessels to guard against wreck and fire may be fundamentally improved.

In the twenty-three years since the international conference met at Washington, there has been substantial growth in the size, speed and comfort of vessels, and the value of property and the number of passengers carried have increased largely. The tonnage of vessels engaged in trade with the United States and the annual value of exports and imports have more than doubled. The total number of passengers and of citizens of the United States carried each year has been multiplied more than three times. The world's tonnage in the merchant marine has increased over 90 per cent. These new conditions have brought new requirements and the loss of the "Titanic" brings suddenly to view the need of an adjustment. It is time that such precautions for the security of life and property as have been outworn and outgrown should be set aside and that inventive genius should be used and encouraged to secure greater safety.

The international marine conference of 1889 met in accordance with an invitation extended through the Diplomatic Service of the United States Government to all the maritime powers of the world. The act of Congress, approved July 9, 1888, under which the conference was held, contemplated that it would be necessary to amend the practice which then existed concerning vessels at sea, measures for the saving of life and property from shipwreck, the reporting, marking and removing of dangerous obstructions, the conveying to mariners warnings of storms, and other matters.

Delegates from twenty-seven nations were present. Rear-Admiral Samuel R. Franklin, U.S.N., was elected Chairman. The other American delegates were Capt. W. T. Samson, U.S.N.; Sumner I. Kimball, General Superintendent, U. S. Life Saving Service; Capt. James W. Norcross, Master Merchant Marine; Capt. John W. Shackford, Master Merchant Marine; William W. Goodrich, Esq., Counsellor-at-Law, and Clement A. Griscom, President, International Navigation Company.

Great Britain was represented by Admiral Sir R. More Molyneux, K.C.B.; Admiral N. Bowden-Smith; Mr. Charles Hall, Q.C.M.P.; Mr. Thomas Gray, C.B., Assistant Secretary Marine Department, Board of Trade; Admiral Sir George Nares, K.C.B.; Capt. Henry Wyatt, P. & O. Steamship Co.; Capt. T. G. Kindall, Dublin Steam Packet Co.

The congress remained in session from October 16 to December 31, 1889, and at its conclusion drew up a full report of its conclusions. Among the suggestions made was that definite lanes or routes be established across the Atlantic, that every vessel in fog, falling snow, or heavy rain should go at a moderate speed, having careful regard for existing circumstances and conditions, and that ocean-going steam vessels which carried passengers should have sufficient life preservers and lifeboats and be provided with efficient bulkheads so placed that when any two compartments were filled with water the vessel would still remain in seaworthy condition.

The most difficult question considered by the conference, and one which proved to be beyond solution at the time, was how to enforce such agreements as might be entered into between the various nations to secure life and property at sea. It was ob-

vious that no agreement could be made effective without some provision for compulsion, and yet no way could be found to compel the adoption of the desired reforms. As one consequence of this dilemma, the establishment of transatlantic lanes was postponed for eleven years and some of the remaining suggestions of the conference remain unacted upon to the present time. It is by no means certain that the difficulties which seemed so insurmountable in 1889 might not be found capable of solution today. The question requires careful consideration by experts versed in international law; but it would seem that the institution of an international oceanic police could be brought about by treaty between the great nations and that such rules and regulations as were made by this body, or for administration by it, could be made as binding as any other article of international agreement. Certainly the question is worthy of careful consideration, and it would seem that the proper way to consider

it would be by a conference of the most capable experts which the maritime nations could bring together.

America's interest in the question of transatlantic safety is second to that of no other nation in the world. More American passengers are carried across the Atlantic than are citizens of any other country, immigrants excepted. While it would not be unsuitable, therefore, for an international marine conference to be held in some other country, both precedent and fitness suggest that the United States extend the invitation to hold the conference here.

Equally appropriate would be The Hague as a place of meeting, since the dignity and authority under which the peace conferences have been held would give desirable prestige to the conclusions of the marine conference. It is important that the conclusions should be as sound as science can make them and as unaffected by national or commercial considerations as is the need for bringing the conference about.



EDITORIAL COMMENT

A COMPARISON OF METHODS

BRIEF news reports of the British inquiry into the "Titanic" disaster seems to show that many important facts are being brought out, from which there may be deduced knowledge of the utmost service in framing such measures as shall ultimately make a catastrophe of the kind almost impossible. This, after all, should be the main purpose. It is vastly more important that ships should not be lost than that wireless operators should be prohibited from selling stories of the loss. It is of much more immediate value to know what happened to the "Titanic," and how, than to know whether news of the total result was temporarily suppressed, or whether some instances of individual selfishness or cowardice could be raked out of the memories of survivors. For if the thing itself can be prevented, all these subsidiary and attendant evils are utterly averted and made impossible.

Certain aggressive spirits asserted that since experts were in charge when the ship met the disaster, its lessons could best be discovered by proceeding with a comprehensive ignorance of almost everything concerning marine construction and navigation, and by dispensing even with practiced skill in the eliciting and dissecting of testimony. This policy has not generally been favored in the conduct of successful industrial and commercial undertakings, and is indeed almost peculiar to the world of politics. A comparison of the results so far reached in the American and British investigations scarcely supports the political theory.

Little can be added editorially to the discussions presented in our leading pages in the articles by Captain

Hobson and Dr. Soper. The one is concerned chiefly with physical questions of construction, best appreciated by one whose life work has been the designing, building, salving and repairing of large craft. The other expresses the thought of a specialist whose life work has been the prevention of accidents and disasters and the preservation of human life, not only in conditions of what might be termed normal existence, but in the face of catastrophes such as that at Galveston, where the relief work and reconstruction were carried on under Dr. Soper's direction. There is neither contradiction nor duplication in these two views. They survey different sides of the same question, each supplementing the other in perfect harmony.

THE CRUISE OF THE BIRMINGHAM

IN the way of immediate, definite, practical contribution to the solution of the great problems involved, nothing is finer than the action of the Navy Department in sending the scout cruiser Birmingham to examine and report the present position, extent and movement of ice in the North Atlantic. With her high speed, her powerful wireless, her skilled direction in this mission, she can furnish exact and complete information to the Hydrographic Office, which now has to depend upon the chance voluntary reports of ship masters. These random reports can at best be but fragmentary, and at worst they are dangerously misleading.

The two or three weeks' cruise of the Birmingham is said to be introductory to the project of establishing a patrol vessel which shall carry on continuous scientific investigations,

by which new and complete illumination will be shed upon the movement of ice in the North Atlantic, and the underlying laws. We may be justly proud that the United States Government has been the first to act constructively in this immense service to the world. It is one of the most significant and important steps taken in modern times for enlarging our knowledge of ocean meteorology. The Navy Department has done the greatest thing that possibly could be done, not only to restore national prestige, but to put us in leadership of the world in reading the lessons of the "Titanic" disaster.

ACCOUNTANCY AND EFFICIENCY

REALIZATION of efficiency is largely a matter of discovering facts and influences in their true proportion and relation. Systems, whether scientific or otherwise, are scarcely more than attempts to compel the correct treatment or use of these factors by others, regardless of whether they see or do not see in correct perspective themselves. Increasing importance, therefore, is likely to attach with the progress of time to those industrial doctrines or philosophies which depend upon mental suggestion more than upon physical institutions; and the schools which use physical institutions must more and more employ mental suggestion to induce the acceptance and employment of their institutions.

A most interesting feature of Major Hine's theory and practice, as shown from the outset in his present series, is this dependence on mental suggestion—this adoption of a new viewpoint to which the official is carried and from which he sees his work and his surroundings in new, broader, and truer relations. Perhaps, however, no single point of view can reveal the entire perspective, and even from that which gives the larger

vision some part may be partly obscured or imperfectly discerned. There is an aspect from which accounting seems to occupy a position of greater importance than is assigned to it by our distinguished contributor. As the scientific mensuration by which alone the proportions and conversions of the whole cycle can be exactly revealed, it asserts something of the same dignity that in the power cycle belongs to the science of thermodynamics.

An interesting commentary on this question from the accountant's side is contained in a recent communication from Mr. William E. McHenry, Auditor of the Cambria Steel Co.

It is true that accounts, the working instrument of the accountant, "are but a yard stick" and that "the yard stick, having been properly tested, is none the better for having made 10,000 measurements"—but this applies equally to the transit, the level, the calculus and the records of the "technical director."

Railroad accounting is simple compared with industrial problems, but in both fields there has been some spirit of antagonism between the technical man and accountant.

The very fact that engineers as a class have been unfamiliar with the principles of cost accounting has made it possible in some instances, for accountants to lead in the field of industrial betterment. Certainly the Industrial Engineer needs accountancy very much as the mining engineer needs geology. The mistake is not in exaggerating the accountancy function but in overestimating the ability of a technically trained mind to grasp complex problems arising from very simple accounting principles, without some practice in their application.

By all means give the technical director, the industrial engineer, a thorough grounding in accounts—particularly in cost accounting—it is vital. But do not conclude that, when you have done this, you have lessened in any degree the necessity of a thorough, detailed and independent control of the movement of values from the bank account, through purchase, manufacture, service, back into the bank account. And it is the "Director of men and things," whether he be Superintendent, Engineer or Technical Director, who needs not only a "reliable, immediate and adequate" source of data, but, from a broader viewpoint, financial control and independent verification of *his* efficiency.

REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA

SANITATION OF CONTRACTORS CAMPS

DISPOSING CAMP WASTE IN THE CONSTRUCTION OF THE CATSKILL AQUEDUCT

A. J. Provost, Jr.*—*Journal Association of Engineering Societies*

IN connection with the construction of the Catskill Aqueduct, which is to supply the City of New York with an additional supply of five hundred and fifty million gallons per day, the Board of Water Supply has undertaken the regulation of the mode of living of the large number of laborers on the work, and the effective disposal of all waste products.

The line of work occupies some hundred miles of territory, and frequently crosses the watersheds of important supplies tributary to the direct supply of New York City. A large majority of the laborers are aliens, which fact necessitated the establishment and maintenance of sanitary precautions not generally employed on similar work. It was considered essential that neighboring communities should be safeguarded against communicable diseases; that pollution of watersheds should be avoided; and finally, to aid the progress of the work, that the health of the laborers themselves should be maintained.

The principles of preventive medicine as applied have aimed at securing and protecting pure supplies of water and food, the vaccination of the force, the isolation of contagious or communicable diseases, laboratory

research of all supplies to the camp, and expert diagnosis of all diseases contracted by the force.

The principles of sanitation as applied have aimed at effecting reasonable cleanliness and the absence of local nuisance and unsanitary conditions. The administration of such work rests in the contractor and general rules and regulations to such effect were incorporated in the specifications and included in each construction contract. It is the contractor's duty to provide and maintain suitable buildings for the housing and needs of his workmen and their families, to provide sufficient supplies of water of proper sanitary quality, to construct and maintain approved methods of wastes collection and disposal, to discharge employees violating the sanitary ordinances, to cause the physical examination and vaccination of all applicants for employment, to provide medicines, surgical and medical treatment for his employees, and to present weekly reports of the population, surgical and medical cases, deaths, vaccinations and sanitary condition of the camp, work, etc.

The main camps for the work are located at Brown's Station, near the site of the Olive Bridge dam, where houses are provided for about 4,000

* Sanitary Expert with the Board of Water Supply of the City of New York.

men, women and children, and at Valhalla near the site of the Kensico dam, occupied at present by about 1,000 people. Along the 90 miles of aqueduct are about 75 other regulated labor camps employing about 15,000 men.

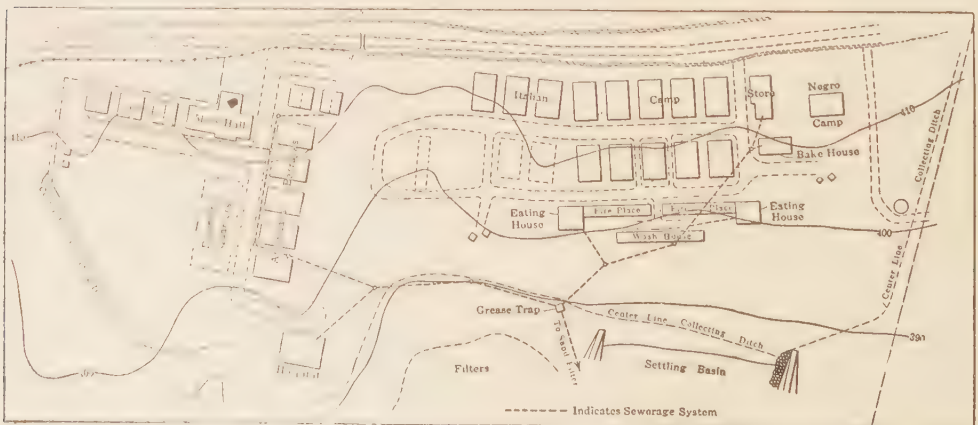
Land for camp sites within the Croton watershed is usually leased or purchased by the contractors after official examination and approval. A carefully prepared topographical map of the site is made, upon which the contractor designates the location of his proposed buildings, water supply and pipings, sewer lines, etc. An aim is made to keep the layout as compact as possible, for the reason that the area is enclosed with a manproof fence, and all rain water falling therein is collected, filtered and sterilized to prevent contamination of the drainage area.

The sanitary works consist of one or more incinerator units, according to the size of the camp, for the combustion of human wastes; one garbage incinerator; drains for the collection of all kitchen, laundry and bath wastes; a grease trap for the reception of these liquid wastes before filtration and sterilization; diverting ditches to exclude rain water falling outside the camp area; collection

ditches and a settling basin with a twenty-four-hour capacity for all water falling within the area; sand filters, two or more units, for filtering all camp rain water after passing through the settling basin, and a chlorinating apparatus for sterilizing filtered camp wash and waste-water before discharge into streams tributary to the New York City water supply.

During working hours away from camp the men are supplied with and obliged to use galvanized iron receptacles. These are returned to camp daily and their contents burned in the incinerators provided for this purpose.

All camp buildings are erected from approved plans. These include sleeping quarters, mess halls and kitchens, wash houses and laundries, hospital and dispensary, isolation hospital, incinerator toilets, stables, etc. Sleeping quarters are provided with 400 cubic feet air capacity, 21½ square feet window area, 1/3 square foot vent openings for each inmate. All windows, doors and vent openings are screened. Not more than eight men are allowed to occupy any room, and the usual procedure is two men per room. The preferred type of bed is a canvas stretcher laced to an iron



CAMP BLAKESLEY. AN IDEAL CAMP ARRANGEMENT IN THE CROTON WATERSHED

pipe frame without mattress or springs.

The storage, preparation and eating of food in sleeping quarters is not allowed. There is usually a recreation room in each barracks, well heated, and the entire building is frequently lighted by electric lights. The mess halls and kitchens are required to be of proper size, well ventilated and thoroughly screened. Wash houses and laundries have cement floors, shower baths, lavatory accommodations and laundry tubs.

The incinerator houses are as a rule modeled after the United States army type with seating capacity based upon one seat for about every twenty persons. This is not thoroughly satisfactory, however, and is being replaced by a modified form which consists essentially of a rectangular building with concrete floor throughout, well lighted, ventilated and screened, with the four corners partitioned off to form separate toilet rooms having three or four seats each. They are provided with removable iron receptacles, the contents of which are transferred to a grate-bar

furnace occupying the central portion of the building.

The stables are, as a rule, well-constructed buildings of ample size, having concrete or non-absorbent floors. All manure is collected and removed daily from the vicinity of the camps. Other buildings usually present are a commissary for storing and sale of food products and a bakery where most excellent bread is, as a rule, prepared.

The conditions to be met are entirely alike at no two camps, and, in like manner, no one camp is at all times equally well administered. Constant cleanliness of the living quarters is one of the most difficult matters connected with the problem. The tendency of the inmates is persistently toward the condition of filth natural to them. Sanitary squads where provided by the contractors are of varying efficiency, and the camp which today may be properly designated as "Spotless Town" will, perhaps, two weeks hence require rebaptism in more senses than one. Constant effort appears to be the price of cleanliness.

THREE-WIRE DIRECT-CURRENT GENERATORS

A SELF-CONTAINED MACHINE FOR OPERATING THREE-WIRE SYSTEMS

William C. Merowitz—Electrical World

BEFORE the present three-wire generator was invented the original three-wire system consisted of two main generators connected in series, each wound for the voltage of the apparatus consuming the energy, a neutral wire running out from the connection between the two machines. When such a system is used both machines must operate continuously. An improvement on this arrangement was made by using a main two-wire generator wound

for the line voltage and a motor-generator set, connected in series across the line. The motor-generator or balancing set consisted of two small machines, which were similar in their construction, and the neutral wire was led out from between them: A small machine on the side, having a lighter load and higher voltage, operating as a motor and driving the other machine as a generator, and thereby balancing the voltages on the system automatically.

The objections to these methods are the greater initial cost and operating expenses of two machines, and the larger floor area required for their operation. Moreover, there are double the number of parts requiring attention and maintenance, and the system as a whole is not as efficient as the present one using the single generator.

The single machine three-wire system can be arranged without change in the machine structure of the ordinary direct-current two-wire generator. The energy is distributed at

The auto-transformer balancing coil is simply a single winding upon a laminated iron core. The middle points of the two coils are connected to the neutral wire as shown in Figure 1. The coils are placed in iron cases, filled with oil, and located near the generator in some convenient place.

Another method for containing the three-wire system with a single armature is shown in Figure 2. The balance coil is connected to two points of the armature winding similar to a single-phase rotary-converter connec-

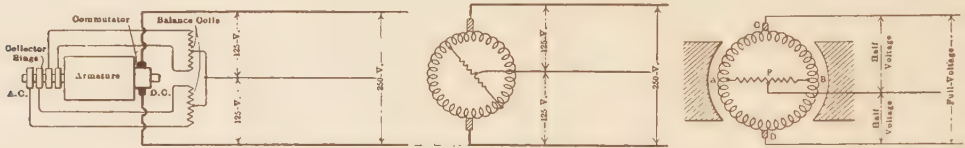


FIG. 1. THREE-WIRE TRANSFORMER SYSTEM. FIG. 2. THREE-WIRE GENERATOR.
FIG. 3. THREE-WIRE GENERATOR

double the voltage of the lamps in circuit, and the neutral wire carries only the unbalanced current corresponding to the difference in the loads on the side circuits of the system. The distribution of the energy at twice the potential of the consuming apparatus effects a saving of nearly two-thirds in the cost of copper over that of the two-wire system. The half voltage obtained from either side of the system is often convenient for variable-speed motor operation.

Figure 1 shows one method for obtaining the three-wire system with a single machine. Two transformers or balancing coils are connected across the two-phase collector rings, which resemble those employed on the alternating-current side of rotary-converter armatures.

The connections from the armature to the rings may be either single-phase, two-phase or three-phase, but the two-phase connection is usually employed on account of the better characteristics obtained.

The neutral winding is then taken from the middle point of this coil and carries only the unbalanced current. Only one collector ring for the neutral wire is necessary, and the auto-transformer is not set in the case of oil.

Two balance coils, shown in Figure 1, give better results than does the arrangement of Figure 2. The latter method has produced a pulsating voltage in some constructions, which caused lamps on its circuit to flicker.

The following explanation will show that the middle point of the balance coils is the neutral point and therefore is the theoretically correct connecting point for the middle wire. In Figure 3 is shown the armature winding of a two-pole machine, used for explanation because it is simpler to understand. Points A and B represent the permanent connections of the balance coil, which is symmetrically placed on the armature winding. The generator brushes are shown

at *C* and *D* and the neutral wire is connected at *F*, which is the middle point of the balance coil. Now, when point *B* is directly under *C* and when *A* is directly under *D* the full generator voltage is impressed upon the balance coil between the points *F* and *C*, and *F* and *D*. That is, the voltage on the balance coil from *F* to *B* and *F* to *A*, when the terminals are under the brushes, is equal to one-half that between *C* and *D*. If the armature is now rotated so that the points *A* and *B* are directly under the poles, as shown in Figure 3, the balance coil is subjected to no difference of potential and the voltage between *F* and *C*, and *F* and *D* are equal to those between *B* and *C*, and *A* and *D* respectively. But since the winding is symmetrical the voltage between *C* and *B* is equal to that between *D* and *A*; therefore there are equal voltages between *F* and *C*, and *F* and *D*. In any other position of the armature the voltage between *F* and *C* is the resultant of half the voltage of the balance coil, and that of the armature winding between *C* and *B*. Correspondingly, the voltage between *F* and *D* is the resultant of those between *A* and *F*, and *A* and *D*. But, as the voltages of *C* and *B*, and *D* and *A* are always equal and *F* is the mid-point of the balance coil, it follows that the voltages between *F* and *C* must always equal that between *F* and *D*, and therefore *F* is the correct neutral point and may be connected to the neutral wire.

The current distribution in the windings of the three-wire generator under conditions of unbalance in load on the two sides is quite similar to that in a single-machine three-wire balancer.

The principles of operation with the three-wire generator are of decided importance in eliminating the cumbersome double-machine unit to

operate a three-wire system. No special knowledge or experience is necessary to operate the machine successfully and after the balancing coils are once in position they require absolutely no attention or maintenance.

The small magnetizing losses in the balance coils can be neglected, so that the performance of the three-wire generator is practically identical with that of two-wire machines.

Three-wire generators are usually wound for either 250 volts or 500 volts in the larger units, and they may be compounded to give a rising voltage with increasing load, as is the standard practice with single-voltage machines. A common practice is to divide the series field turns into two parts, connecting one part in the positive and the other in the negative leads, in order to preserve the balance at all loads. Three-wire generators may be successfully operated in parallel with each other without danger of short-circuiting when the machines are brought up to speed, and they may also be operated in parallel with two-wire generators.

The possible applications of the three-wire system are quite numerous, but its principal fields of service are in the distribution of energy for lighting and motor service in office buildings, manufacturing plants, stores, machine shops, etc. It has been also successfully applied to mining service for distributing energy underground to distances between 1 mile and 2 miles. The two voltages delivered by these generators are convenient and advantageous for variable-speed motor operation, as the flexibility of the system provides a wide range of speeds with field control, while the saving in copper is an advantage which is likely to have considerable bearing on prospective installations,

SLIME AGITATION

ADVANTAGES SECURED BY THE PARRAL TANK OVER THE PACHUCA TANK

Bernard Macdonald—American Institute of Mining Engineers

IN cyanide plants built before 1907, agitation was effected in tanks 10 to 12 feet deep, and ranging in diameter up to 30 feet, by mechanically revolving stirring-arms, assisted by centrifugal pumps drawing the settled pulp from the bottom of the tank and throwing it back on the top of the charge in the same tank. This method was fairly efficient, but expensive in both the construction and operation of the plant; and it was superseded by pneumatic or air-lift agitation, which proved to be at least equally efficient, and more economical.

The method of air-lift agitation which came into general use in cyanide plants is known as the Pachuca tank system. That this system was a great improvement over any other previously employed, there is no question; but that it has a number of commercial defects, is also true.

All these defects result from the design of the tank, and the apparatus with which it is equipped, the tank dimensions being at variance with all the principles governing the object—other than as stand-pipes—for which tanks are employed. The great height and small diameter make the holding capacity comparatively small, and consequently its cost of construction per unit of holding capacity, high. The height of the tank and the large diameter of the air-lift tube necessitate a correspondingly high pressure and a large volume of compressed air to effect the transfer of the pulp, and adds to the cost of agitation.

The pulp transferred through the air-lift tube overflows on the top of the charge, close around the tube, in which relative position the solid par-

ticles settle vertically to the bottom, where the steep sloping sides of the cone bottom carry them to the intake of the air-lift tube, which throws them back on the top of the charge. Under normal conditions of operation, the air-lift tube turns over the entire charge in a Pachuca tank of standard size in about 15 minutes. The violence of this operation would not be necessary to keep the pulp in proper mixture, but on account of the tall, narrow tank and the conical bottom, it is necessary in order to keep the air-lift tube and air-nozzle from being choked.

The principal defect of the air-nozzle of the Pachuca tank is the amount of ineffective work that must be done by the compressed air in making its numerous jet-like escapes into the air-lift tube. The superficial area of the exterior of the rubber stocking, that must open and close for each jet of air escaping, is at least 36 square inches; and on each inch of this area there is a continuous pressure of 0.54 pound per foot in height of the tank-charge. As filled in operating, there is 43 feet of pulp in the tank, making an external pressure of 23.22 pounds per square inch, or a total of 836 pounds on the movable part of the stocking, which weight must be lifted by each jet of air admitted to the air-lift tube. In view of the great frequency of the air-jets, the enormous amount of useless work which this form of valve necessitates is apparent. Moreover, the numerous alternate openings and closings of the rubber stocking soon destroy its elasticity and wear it out.

The Parral tank is flat-bottomed, 25 feet in diameter and 42 feet high,

with a capacity three times as great as that of the standard Pachuca tank. For transferring pulp from the bottom to the top of the tank, four 12-inch transfer-pipes are set 12 inches from the bottom, 4 feet from the tank side, and equidistant from each other. The compressed air is admitted into these pipes through a patent nozzle

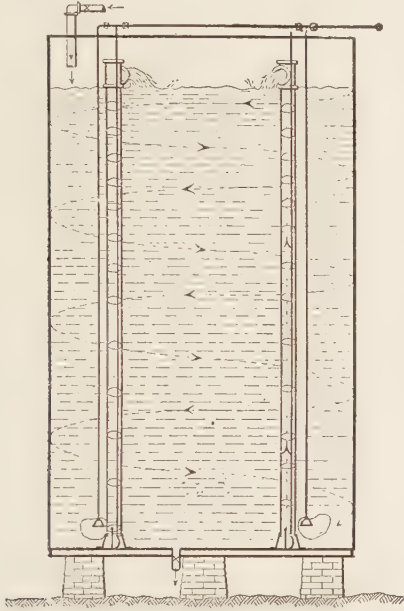


FIG. 1. PHANTOM VIEW OF PARRAL TANK

fitted with a ball-valve, which automatically opens and closes, intermittently, as required in the jet-feeding of the compressed air. In case of failure in the supply of compressed air, and in the momentary intervals between issues of the jet, the air-nozzle is securely sealed by the ball, and the entrance of pulp into the air pipes is prevented.

On the delivery end of the transfer pipes, tees of equal diameter are bolted, with the run in line with the pipes and the outlets so directed as to discharge the pulp in lines of segment chords to the circumference of the tank. The discharge of all the trans-

fer pipes is in the same direction, and the force of the discharge sets up a spiral or rotary flow in the tank-charge which, in a short time, extends down to the bottom of the tank.

Figures 1 and 2 show the pulp discharging from the transfer-pipes, and the undulations of the rotary flow set up in the tank-charge. When Parral tanks are receiving their charge

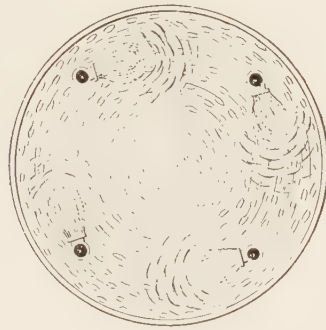


FIG. 2. TOP VIEW, SHOWING ROTARY MOTION

for individual charge-treatment, an auxiliary air-pipe is extended down alongside each transfer-pipe to a point near the bottom of the tank, and the compressed air issuing from these pipes keeps the pulp in agitation and prevents it from settling on the bottom. In the continuous system this pipe is never used. When the tank is filled to within 10 or 12 feet of the top, the air is closed off the auxiliary pipes and turned on in the transfer pipes.

The spiral flow set up in the tank, as shown in Figures 1 and 2, carries the pulp particles round and round, so that the distance travelled by the pulp from the time it is delivered at the top until it reaches the bottom is many times greater than if it settled vertically, as in the Pachuca tank. In other words, the solids are carried in suspension by the rotary flow of the solution as they would be carried in a flowing river; the settlement of the

heavier particles is thus retarded; and, consequently, the necessity for transferring the pulp from the bottom of the tank to the top is proportionately lessened, and the cost of the work is comparatively reduced.

In the Parral-tank system no special diameter of tank need be adhered to as in the Pachuca system. The relation of the diameter to the height of the tank may be whatever is economical in its holding capacity, which should be the main consideration in determining the diameters of tanks.

To secure, under this system, perfect agitation and the necessary ro-

tary flow in tanks of the largest diameter, it would only be necessary to install a proper number of transfer pipes, with discharge outlets placed in the right direction to set up and maintain the rotary flow. A Parral tank of the same capacity as a standard Pachuca tank, would be 15 feet in height by 25 feet in diameter, and would be equipped with four 8-inch transfer pipes; while the necessary pressure of air would be only 8.5 pounds per square inch. The comparative cost of construction and operation of these two types of tanks is easily estimated.

RAIL FAILURES

ECCENTRIC LOADING BY CONED WHEELS THE PRIMARY CAUSE

C. A. Morse—Railway Age Gazette*

ACCIDENTS due to broken rails, such as that on the Lehigh Valley, have caused the national government to investigate the quality of steel rails being made at the present time. While the subject has been under the careful consideration of railways and railway associations for some period of years, yet the line of consideration has tended mainly toward the quality of steel in the rail and practically not at all toward the design of the rail itself.

Even as far back as 1889, when wheel loads were much less than present practice, Mr. D. J. Whittemore, Past President of the American Society of Civil Engineers, wrote an exhaustive article in which he proposed that cylindrical wheels and flat top rails be used on railways, and called attention to the fact that, owing to the small area of contact between wheel and rail, the elastic limit of the metal in the rail was exceeded.

One point which was not discussed

in that paper was the eccentric loading of the rail. The present standard design of car wheels, which has existed for years, has a taper or coning of one in twenty. The theory of this coning is, apparently, that the cone tends to equalize the diameter of the

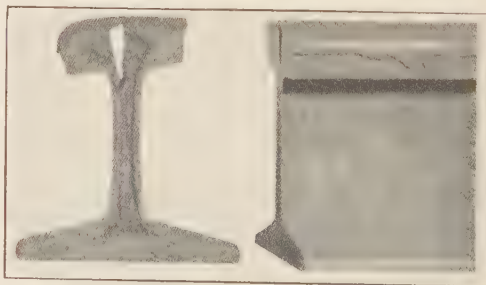


FIG. 1. TYPICAL RAIL FAILURE

wheel in passing around curves; that owing to the widening of the gauge on curves and the play in the boxes of the truck the larger diameter of the wheels was brought in play on the outside rail and the smaller diameter on the inside rail tending to prevent slippage and to overcome the differ-

*Chief Engineer of the Atchison, Topeka and Santa Fe Railway System.

ence in distance around the curve on the two rails. The theory is good, but of no value under present conditions. In modern practice the gauge is not widened up to 8 or even 10 degree curves. The wear on the tread of the wheels soon does away with the coning, and practically there is no difference in the diameter of the wheel in the width that any play in the truck boxes permits.

In the case of a new wheel and a new rail the coning of the wheel causes the line of pressure in a standard wheel and a 90 pound standard rail to be located 0.7 inch away from the centre of the rail toward the inner edge of the head, thus loading the rail eccentrically and tending to split the head, to split the web of the rail longitudinally, and, owing to the area of contact being only from one-third to one-half a square inch, exceeding the elastic limit of the metal, which naturally causes a flow toward the inside edge of the rail. In the design of structures, eccentric loading is carefully avoided, but in the case of a steel rail, subject as it is to repeated application of loads, the matter seems to have been completely ignored.

The strains in the head of a rail due to wheel loads are so numerous that the combined effect of a number of them is very hard on the rail. Owing to the conditions of surface, grade and speed, these different strains can be combined in a variety of ways, each combination tending to disrupt the head of the rail, split the web, or cause the metal to flow over the edge, and when these combinations are repeated thousands of times it is not strange that fracture occurs.

Rail failures due to head troubles have become so numerous during the past few years as to attract special attention. On one road during 1910, there were 1,146 breakages of 85 and

95 pound rails, of which 50 per cent were due to head and web troubles. In 1911, out of 1,350 breakages in 85 and 90 pound rails, 62 per cent were in the head and web.

By doing away with the coning of wheels and having a cylindrical wheel, the bearing of the load would be in the center of the head directly over the web, entirely eliminating eccentric loading. With the point of contact in the center of the head of the rail any wear or flow of metal would tend to increase the area of contact and decrease the pressure per square inch. The present American

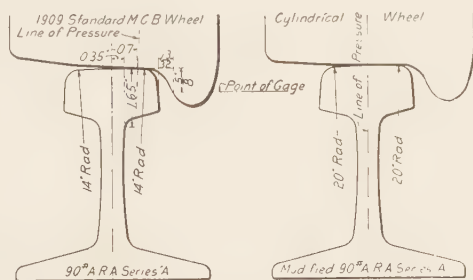


FIG. 2. PRESENT AND SUGGESTED SECTIONS SHOWING POINT OF APPLICATION OF LOAD

Railway Association rail section has a radius of 14 inches for the top of the head. This radius increased to 20 inches would afford a greater area of contact between a new rail and a new wheel, and thus the tendency to wear and flow would be materially reduced.

While it is true that both rail and tire rapidly become worn so as to give a larger area of contact, yet on lines of heavy power new rails and tires are constantly being placed, and locomotive wheel tires are turned down often enough to give the effect of new wheels.

Some railways and locomotive works have adopted the practice of reducing the taper on locomotive tires to one in 38 instead of one in 20. While this is a step in the right direction, yet the author can see no reason for preserving any taper.



FIG. 1. ACTUAL PHOTOGRAPHS OF A JAPANESE STEAMSHIP SINKING AT SEA

THE WRECK OF THE "TITANIC"

OPINIONS ON BULKHEAD SYSTEMS, MASS EFFECTS IN COLLISIONS, LIFE-BOAT PROVISION, ICEBERG DETECTION AND THE UTILITY OF RADIOTELEGRAPHY

The Engineer, Scientific American, Engineering News, Engineering

THE appalling disaster to the White Star Liner "Titanic" on Sunday night, the 14th of April, by which more than 1,600 of the passengers and crew lost their lives, has brought several scientific subjects into prominence. These subjects are: The conditions of stability of a vessel built upon the watertight bulkhead system when an extensive injury has been isolated by closing the watertight doors; the dynamic effects of a mass of 45,000 tons moving at a speed of 20 knots; more rigid regulation in the provision for, and placement of, sufficient life-boat capacity for a full complement of passengers and crew; the means of detecting the presence of adjacent icebergs, and the beneficent use of the wireless telegraph to vessels in distress.

Suggestions tending toward an increase of efficiency in water-tight bulkhead systems, and proposals for the formation of an International Marine Conference to investigate such matters, will be found in the articles by Captain Richmond P. Hobson and George A. Soper on other pages of this magazine.

With regard to the first subject, bulkhead structure, *The Engineer* (London) says, that while "there has

grown up a widely prevalent belief that a modern passenger liner is able to defy any conceivable set of circumstances producing sea damage and to remain afloat, the idea is quite erroneous, and no ship has yet been designed or built which will remain afloat after an accident, which, as an example, may have ripped her bottom away for half her length. The idea probably had its origin in the effort of the designer to attain the standard set up by the Bulkhead Committee in 1890. That standard may be summarized as this: That the watertight bulkheads should be so spaced throughout the length of the vessel that when any two adjoining compartments are laid open to the sea the vessel may be able to float in moderate weather. From a consideration of the published illustrations of this steamer ("Titanic"), it would appear very probable that the conditions referred to above were more than complied with. Excluding certain bunker bulkheads, fifteen transverse watertight bulkheads were fitted, judiciously disposed throughout the length of the vessel. The after-bulkheads extended to the saloon deck, whilst the foreward bulkheads extended to the deck next below."

In regard to the watertightness of

the bulkheads the same journal says: "It is evident that if a ship is injured foreward, consequent upon the resultant deeper immersion and change of trim, a bulkhead may be called upon to withstand a pressure due to a head of water extending to the bulkhead deck. Now under conditions like this even the static stresses induced in the bulkhead stiffeners, as provided in the table in the Bulkhead Committee's Report, are in many cases too high. Indeed, it will not be found that any consistent standard of strength is observable under conditions implied by the existence of the bulkhead itself. We therefore think that the time is ripe for a revision of this table of scantlings, representing virtually a statutory standard, and it is hoped that the discussion which is bound to follow the loss of the 'Titanic' may be so extended as to include the validity of these requirements."

On this same subject, Professor J. H. Biles, in *The Engineer*, says: "Two compartments of the unreduced length can be flooded, and the ship will be safe. But for damage of a more extended nature the determining factor will be the length of side damaged and the consequent length of compartments open to the sea, and no internal subdivision can appreciably reduce this. The only way to meet a contingency is to increase the margin of safety; in other words, the bulkhead deck must be raised considerably."

"And yet," says *Scientific American* (New York), on the matter of impact effects, "that underwater blow would scarcely have been fatal had the ship been put, as she should have been under half speed. For then the force of the reactive blow would have been reduced to one-fourth. The energy of a moving mass increases as the square of the veloc-

ity. The 60,000-ton 'Titanic' at 21 knots, represented an energy of 1,161,000 foot-tons. At 10 knots, her energy would have been reduced to 290,250 foot-tons. The giant vessel was capable of striking a blow equal to the combined broadsides of the twenty 12-inch guns of the 'Delaware' and 'North Dakota,' each of whose guns develops 50,000 foot-tons at the muzzle.

"So slight, in proportion to the enormous total energy of the vessel, was the energy absorbed in tearing open the hull or the bottom, or both, that the passengers were scarcely disturbed by the shock."

"It is doubtful whether even ship-owners realize," to quote from the *Engineering News* (New York), "that the larger a vessel is, the more fragile is its outer skin. By fragile we refer not to the stresses from wave action, but to the danger of injury by collision with piers, tugs or other ships, or from grounding. It is true, of course, that the larger vessel has thicker plates and heavier frames, but the thickness is by no means in proportion to the increased size, weight and inertia. If one desires an instructive comparison between a large vessel and a small one in the matter of withstanding external blows, let him compare the process of bringing a light river or lake steamer up to a pier with the same process where an ocean vessel of 20,000 tons is concerned.

"In the 'Titanic's' collision with the floating ice mass which sent her to the bottom, there are probably few outside the engineering profession who realize that the pressure produced against the vessel by collision with any stationary object increases directly with the tonnage of the vessel."

It is unquestionable that the "Titanic" complied fully with the letter

of the regulations imposed by the British Board of Trade in the matter of lifeboat provision, even to a slight excess over the cubical capacity called for, but it is equally unquestionable that such provision was inadequate.

The comparative requirements of the British and American laws on the matter are outlined in *Engineering* (London) as follows:

"The Board of Trade calls for the carrying, by ships of 10,000 tons and over, of a minimum of sixteen boats, with a total minimum cubic capacity of 5,500 feet. It is further indicated that 'if the boats placed under davits do not furnish sufficient accommodation for all persons on board, then

the suitability of all ships for passenger service, and should have altered their regulations from time to time to meet the requirements of advancing practice."

Had the "Titanic" been an American ship, complying with American regulations, the lifeboat capacity would have been about 24,000 cubic feet, which would have been sufficient to carry about 2,400 passengers.

If more lifeboats are to be carried by liners, the question has been raised as to the most advantageous method of placing them to be at once available for duty, and yet non-obstructive to passageway. *Scientific American* suggests that the deckhouse struc-

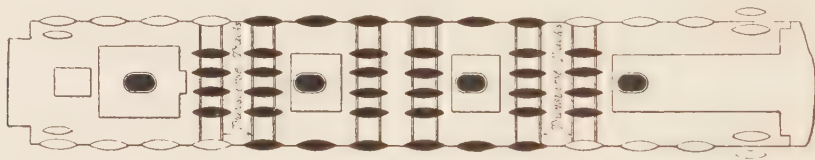


FIG. 2. PLAN OF BOAT-DECK WITH ACCOMMODATIONS FOR 56 BOATS

additional wood, metal, collapsible, or other boats of approved design or approved life-rafts shall be carried.' In the case of all ships over 10,000 tons the total capacity of all lifeboats, life-rafts, etc., required by the Board of Trade regulations was 9,625 cubic feet, and as 10 cubic feet was deemed sufficient for each passenger, the total provision was thus for 962 passengers. The American law requires that in vessels of 20,000 gross tons, the boats carried should have a capacity of 12,420 cubic feet, with an addition of 225 cubic feet for each successive 500 tons above 20,000 tons. There is no doubt that the accommodation in the 'Titanic' greatly exceeded the requirements of the British law, but was less than those of the American law."

The same journal censures the apparent laxity of the British Board of Trade, for that Government department is "responsible for certifying

tures be removed from the boat deck of the ship, and the 56 boats, sufficient to carry 3,100 people, be arranged as illustrated in Figure 2. (Compare with diagram showing present arrangement, in Captain Hobson's article.) A full line of boats is carried in davits the length of the boat-deck rails, and between each pair of smokestacks two lines of four boats each are stowed athwartship. "The chocks in which these boats rest are provided with gunmetal wheels, which run in transverse gunmetal tracks, countersunk on the deck. As soon as the boat at the rail is loaded and lowered, the next boat inboard is wheeled to the davits and loaded, ready to be picked up and swung outboard as soon as the tackle has been cast loose from the boat that has been lowered."

Opinion on the infallibility of any tests for the accurate detection of the

presence of icebergs varies to a marked extent. Especially is this the case in the consideration of the temperature of the sea in the vicinity of bergs. The following information given by the United States Hydrographic Offices admits that any present method of physical detection is indefinite.

"The temperature of the air falls as ice is approached, especially on the leeward side; but generally only at an inconsiderable distance from it. The fall of the temperature of the sea water is sometimes a sign of the proximity of ice, although in regions where there is an intermixture of cold and warm currents going on, as at the junction of the Labrador Current and the Gulf Stream, the temperature of the sea has been known to rise as the ice is approached. If a berg be

grounded, water flowing past it will be lowered in temperature and thus give an indication of its presence. Change of temperature may, therefore, serve as a warning, and frequent observations, both of the temperature of the air and the sea, should be taken and considered."

In only a few cases since its installation has wireless telegraphy played such an important part as it did at the time of the "Titanic" disaster. The greatest praise is given on all sides to the bravery of the two operators who stayed by their instruments until the vessel sank. Deprived of the assistance rendered through this medium, it is extremely doubtful whether any of the lifeboats would have been picked up, and the loss of the vessel would have remained one of the mysteries of the period.

ELECTRIC FURNACE PRODUCTION OF PIG IRON AND PIG STEEL

EIGHTEEN MONTHS' OPERATION OF THE TROLLHÄTTEN FURNACE, SWEDEN

J. W. Richards—Proceedings Engineers' Society of Western Pennsylvania

IN our issues of December, 1909, and August, 1911, we reviewed briefly the results of the Domnarfvet experiments with the pioneer electric furnaces, and the later experiments by the Jern Kontoret at Trollhättan published after a five months' trial with an improved furnace. In Mr. Richards' paper before the Engineers' Society of Western Pennsylvania is presented an historical résumé of the birth of the idea of electric furnaces for producing pig iron; the enthusiastic experimental work by the three young Swedish engineers, Groenwall, Lindblad and Stalhane, and the later work done by the Iron and Steel Makers Association of Sweden, the "Jern Kontoret," who purchased all the patents.

The Swedish Government, realizing the national importance of the iron industry, and recognizing the decreasing supply of charcoal, has offered all possible assistance in the endeavors of the Association. This assistance has been rendered mainly in the supply of practically free power for a period of two years at its plant at Trollhätten.

The Trollhätten furnace has now been in operation about a year and a half, with results exceeding all expectations. The type of furnace has been considerably improved, and a statement made by Mr. Groenwall was to the effect that there would be installed in Norway and Sweden during 1912 plants representing a total of 25,000 horse power.

The most important point in the operation of the electric furnace as compared to the blast furnace in the production of pig iron is that the furnace requires only one-third as much carbon per ton of iron as the blast furnace. The maximum amount of carbon which can be used to reduce iron oxide to iron is 36 carbon to 112 iron. Not only is it useless to put more carbon into the furnace than is thus theoretically required, but it is absolutely prejudicial to the running of the electric furnace. Having a fixed weight of oxygen to be taken away from the iron, if taken by carbon forming CO, the formation of this CO gives a certain amount of heat, contributed to the furnace; if changed to CO₂, more heat is contributed to the furnace, because when carbon unites with oxygen to form CO₂ it gives out more heat per unit of oxygen combined than when it forms CO. Therefore the less carbon is used in the furnace, the more heat

of oxidation is derived therefrom. The Swedish furnaces have confirmed this principle, and as economy in carbon is reached and less fuel is used, also less electric energy is used, and a higher degree of efficiency is obtained.

The power actually required by this Swedish furnace has been about



FIG. 2. ELECTRODE HALF CONSUMED

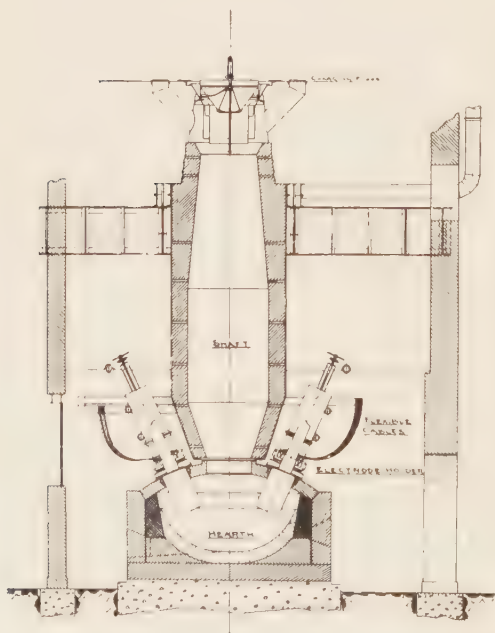


FIG. 1. SHOWING NEW MONOLITHIC ELECTRODES WITH PERMANENTLY PLACED CONNECTIONS AGAINST ARCH OF CRUCIBLE

one-third of a horse-power-year per ton of pig iron. As the size of furnace is increased the power consumption will probably be decreased to one-fifth of a horse-power-year.

The consumption of electrodes is an item which gave great concern on account of the 50 per cent waste due to unconsumed stumpage. This waste has been eliminated in recent practice by the manufacture of electrodes 24 inches in diameter, six feet long, fitted with a screw and socket so that they may be screwed into each other, end to end. When the electrode is down as far as it can go, a new one is screwed on top and thus the butt is entirely used.

In the electric furnace the gases produced weigh less than the weight of the pig iron. There is only the carbon monoxide and dioxide formed from the reduction of the ore; and this, passing up the furnace, does not capably carry to the upper part the

heat generated in the lower part by the electric energy. This difficulty has been partly overcome by the Swedish engineers by repeated circulation of the gases.

The pig iron produced has been the equal in all respects to Swedish charcoal pig iron. The product is more free from oxides and nitrogen than ordinary pig iron, which counts heavily in making fine steel.

By cutting down the amount of carbon used for reducing, the furnace worked better, consumed less power and less carbon, worked more rapidly, and produced a pig iron which was white instead of gray. By reducing the amount of fuel and running at a lower temperature, a product was

obtained with 0.1 percent silicon, 0.1 percent manganese, and as low as 1.5 percent carbon. This product was called pig steel as it bears all semblance to crude steel.

This discovery was more or less accidental, but they were not long in seeing the immense importance of having crude material which could be converted into steel so easily that it nearly doubled the output of their open-hearth furnaces and also increased the output of their electric pig-iron furnaces. The pig iron furnace makes more of this pig steel in a day than it did of pig iron, and at less cost; the steel furnace makes more steel per day from this material and at less cost.

THE MINIMUM WAGE ACT

A SUBSTANTIAL REVIEW OF THE TEXT OF THE BRITISH COAL MINE ACT

The Colliery Guardian

THE Act providing a minimum wage for workmen employed in coal mines and which received the Royal Assent on the 29th of March, is substantially as follows:

1. It shall be implied in all contracts for the employment of workmen in coal mines that the employer shall pay wages not less than the amount specified by the Act, unless the workman should be excluded from the provisions of the Act by not complying with the district rules, or has forfeited his rights to such payment by proving himself irregular or inefficient.

The term "district rules" means such rules as may be made by the authorized joint district board.

The district rules shall provide, as respects the district to which they apply, for the exclusion from the right to wages at the minimum rate of aged and infirm workmen, and

shall lay down conditions with respect to the regularity and efficiency of the work to be performed by the workmen, and provide that a workman shall forfeit the right to wages at the minimum rate if he does not comply with those conditions, except in cases where the failure to comply with the conditions is due to some cause over which he has no control.

The district rules shall also provide for the decision of any question whether any workman in the district is a workman to whom the minimum rate of wages is applicable, or whether a workman who has not complied with the conditions laid down by the rules has forfeited his right to wages at a minimum rate, and for a certificate being given of any such decision for the purpose of this section.

The provisions of this section as to payment of wages at a minimum rate shall operate as from the date of the

passing of this Act, although a minimum rate of wages may not have been settled, and any sum which would have been payable under this section to a workman on account of wages if a minimum rate had been settled may be recovered by the workman from his employer at any time after the rate is settled.

2. Minimum rates of wages and district rules for the purpose of this Act shall be settled separately for each of the districts named in the Schedule to this Act by a body of persons recognised by the Board of Trade as the joint district board for that district.

The Board of Trade may recognise as a joint district board for any district any body of persons, whether existing at the time of the passing of this Act or constituted for the purposes of this Act, which in the opinion of the Board of Trade fairly and adequately represents the workmen in coal mines in the district and the employers of these workmen, and the chairman of which is an independent person appointed by agreement between the persons representing the workmen and employers respectively on the body, or in default of agreement by the Board of Trade.

The joint district board of a district shall settle a general minimum rate of wages and general district rules for their district, and such shall be the rates and rules applicable throughout the whole of the district to all coal mines in the district and to all workmen or classes of workmen employed underground in those mines, other than to such miners and workmen to whom a special minimum rate or special district rules may be applicable.

The joint district board of any district shall, if it is shown to them that any general district minimum rate or general district rules are not ap-

plicable in the case of any coal mine within the district, or of any class of coal mines within the district, or in the case of any class of workmen, owing to the special circumstances of the mine or class of mine or workmen, settle a special minimum rate (either higher or lower than the general district rate) or special district rules (either more or less stringent than the general district rules) for that mine or class of mines or class of workmen, and any such special rate or special rules shall be the rate or rules applicable to that mine, class of mine, or class of workmen instead of the general district minimum rate or rules.

For the purpose of settling a minimum rate of wage the joint district board may subdivide their district, and in that case each part of the district as so subdivided shall, for the purpose of the minimum rate, be treated as the district.

For the purpose of settling district rules, any joint district boards may agree that their districts shall be treated as one district, and in that case those districts should be treated for that purpose as one combined district, with a combined district committee appointed as may be agreed between the joint district boards concerned, and the chairman of such one of the districts forming the combination as may be agreed upon between the joint district boards concerned, or, in default of agreement, determined by the Board of Trade, shall be the chairman of the combined district committee.

3. Any minimum rate of wages or district rules settled under this Act shall remain in force until varied in accordance with the provision of this Act.

The joint district board of a district shall have power to vary any minimum rate of wages or district

rules for the time being in force in their district—

(a) at any time by agreement between the members of the joint district board representing the workmen and the members representing the employers; and

(b) after one year has elapsed since the rate or rules were last settled or varied, on an application made with three months' notice given after the expiration of the year by any workmen or employers, which appears to the joint district board to represent any considerable body of opinion amongst either the workmen or the employers concerned;

—and the provisions of this Act as to the settlement of minimum rates of wages or district rules shall, so far as applicable, apply to the variation of any such rate or rules.

4. If within two weeks after the passing of this Act a joint district board has not been recognised by the Board of Trade for any district, or if at any time after the passing of this Act any occasion arises from the exercise or performance in any district of any power or duty under this Act by the joint district board, and there is no joint district board for the district, the Board of Trade may appoint such person as they think fit to act in the place of the joint district board,

and, while that appointment continues, this Act shall be construed, so far as respects that district, as if the person so appointed were substituted for the joint district board.

If within five weeks after the passing of this Act the joint district board for any district fail to perform any duty with respect to the settling of the first minimum rate of wages and district rules in that district, the chairman of the joint district board shall perform that duty in place of the joint district board, and any minimum rate of wages or district rules settled by him shall have the same effect for the purposes of this Act as if they had been settled by the joint district board:

Provided that, if the members of the joint district board representing the workmen and the members representing the employers agree, or if the Board of Trade on a report from the chairman of the district board direct, that a specified period longer than five weeks shall for the purposes of this subsection be substituted for five weeks, this subsection shall have effect as if that specified period were therein substituted for five weeks.

This Act shall continue in force for three years from the date of the passage thereof and no longer unless Parliament shall otherwise determine.

CROSS-TIES FOR PRESERVATIVE TREATMENT

SAWED VERSUS HEWED TIES AND THE DISTRIBUTION OF SAPWOOD

Howard F. Weiss—Railway Age Gazette*

PRESENT railway specifications for the quality of cross-ties, in the United States, cover only the general features that the ties shall be of sound timber, free from any imperfections tending to impair their strength and durability, that they must have two parallel faces

sawed or hewed smooth, and that the ends shall be squared. Another factor, not generally considered in the specifications but which seems of equal importance to the author, is the sapwood content, especially in ties which are to be given some preservative treatment.

*Assistant Director in the Forest Products Laboratory of the Department of Agriculture at Madison, Wisconsin.

A comparative study of the number of cross-ties purchased by the railways during a period of four years shows that by far the larger number of ties are hewed rather than sawed, the percentage varying between 75 and 82 per cent of the total number cut during each year. The reasons for this may be as follows:

(1) The general impression among railway engineers has been that hewed ties shed water better than sawed ties and hence are more durable. Attempts to secure authenticated data substantiating this belief have failed, and even if the claim were valid, it would be of no importance when the ties are to be given a preservative treatment.

(2) Hewed ties are generally cut with a straighter grain than sawed ties, and hence are claimed to have superior strength. While this may be true when the fibers of the wood are at variance with the axis of the tie, yet the difference in strength between the two is but slight, for in both methods some of the fibres will be ruptured in manufacture.

(3) In ordering hewed ties it is claimed that the railway gains by securing a volume of wood larger than if the ties were sawed, because when sawed, the ties are cut to fixed dimensions, whereas in hewing they are usually cut only to keep above the minimum dimensions, and this volume consequently is generally greater than that specified. While this claim is unquestionably true in many instances, nevertheless it is more than offset by the disadvantage of this method of manufacture.

(4) Perhaps the chief and best reason why most ties now used are hewed is the economic condition surrounding their production. Railways generally secure cross-ties from three sources; from tie companies, from farmers and others holding small

bodies of timber along the right-of-way, and from cuttings on their own holdings. It frequently happens that it is easier and cheaper for a farmer to hew a few ties, hauling them to the railway or town for sale, than it is for him to haul his logs to a sawmill and have them sawed. Where such and similar conditions exist, the hewing of ties is justifiable, as it is the best practical means for utilizing the timber. However, there are many instances where large owners of timber could saw it into ties rather than have it hewed, and by so doing would not only bring about a closer utilization of their own material, but would furnish the railway companies with a better product. It is largely this class of operators who can bring about a most immediate improvement in the method of manufacturing wooden ties.

The chief reasons why sawed ties should be used are as follows:

(1) Hewing cross-ties results in waste of much valuable material, the aggregate volume thus wasted being even greater than the volume of the wood in the tie. This is an absolute waste, being put to no use, whatever, since the refuse is left in the woods to rot. When logs are sawed into ties rather than hewed, much of this material can often be utilized, especially in the case of large logs which are capable of furnishing more than the volume of one tie. In addition to the boards which can thus be obtained, there is an enormous amount of wood which even now has value as fuel, and there is no doubt but that this value will be increased in the immediate future due to the utilization of the waste wood for the manufacture of other products.

(2) A sawed tie is cut to specific dimensions except when it is made from a small-sized log and only slabbled on two faces. With this more

accurate volume, it is much easier when the ties are placed in a treating cylinder, to determine the absorption of the preservative per cubic foot than when the volume of the ties is extremely variable. Most treating specifications call for an absorption of a definite quantity of preservative per cubic foot of wood, and unless the volume of the wood is accurately known, the absorption per cubic foot cannot be accurately applied, and the treatment is bound to be at variance with the specification.

(3) More sawed ties can as a rule be piled on a cylinder buggy than hewed ties. This not only increases the output of the plant, but decreases the cost of treatment.

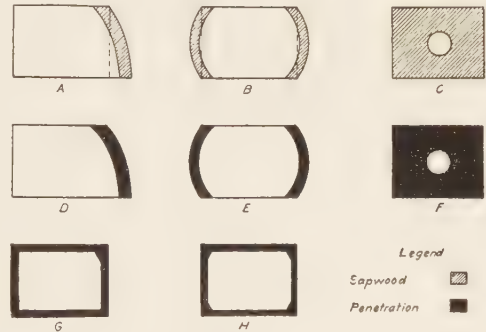
(4) Ties are very seldom hewed so carefully that tie plates or rails will bear uniformly upon them; consequently, it is almost invariably necessary to adze hewed ties in order to secure a satisfactory bearing for the rail. With sawed ties such adzing can generally be entirely eliminated.

(5) Hewed ties possess much needless volume and also have much needless weight, hence they are more expensive to handle and transport than ties whose volume and weight are more uniform.

Entirely aside from the question as to whether ties should be sawed or hewed, is the point so greatly overlooked in manufacture, that is, the distribution of sapwood in the tie. It is just as logical to specify how ties to be treated shall be cut as regards their sapwood content, as to specify a difference in price due to the kind of wood. Sapwood lends itself very readily to treatment, while heartwood is generally very resistant. When ties composed of part sapwood and part heartwood are placed in a cylinder and injected with a preservative, most of the preservative will go into the sapwood. To secure the best re-

sults it is of considerable importance, therefore, to specify how this sapwood shall be distributed. The best kind of tie for the purpose is one which has a uniform amount of sapwood on all surfaces, as shown at C in the accompanying figure. Such a tie can be very effectively protected against decay.

Unfortunately, only a comparatively small number of ties are of this kind, and even those that are, are usually of low crushing strength. By



SHOWING INFLUENCE OF SAPWOOD ON PENETRATION OF PRESERVATIVES

far the largest percentage of ties now used are composed mostly of heartwood or needless, sapwood, as shown at A and B. When ties of this kind are treated according to the ordinary specifications, practically all of the preservative will go into the sapwood in most species, leaving the heart faces with only a superficial penetration. The greatest wear on a tie comes on its face immediately under the rail or plate, and this is the portion which should have the greatest and not the least protection. If ties of the type shown in Figures A and B are treated, they can unquestionably be made to absorb the amount of preservative specified—say 10 pounds per cubic foot—but most of the preservative will be in those portions of the tie where it will do the least good. If, however, these ties were sawed as indicated by the dot-

ted lines, it would be possible to secure just as long a life from them with a much less consumption of preservative.

For example, consider a modern treating plant having an output of approximately 800,000 ties per year: If the ties are impregnated with 10 pounds of creosote per cubic foot, the oil costing 6 cents per gallon and the ties containing approximately 3 cubic feet, the total amount of the oil used would be approximately 24,000,000 gallons. If the ties had been cut as indicated in the sketch, it would be possible with a consumption of about 6 pounds of creosote per cubic foot to protect them as effectively as with 10 pounds in the former case. This would result in a net saving of approximately 4 pounds per cubic foot, or 12 pounds per tie, equivalent to about 9 cents per tie for cost of pre-

servative, or \$72,000 in one year's operation of the plant.

In the accompanying sketch Figures A, B, and C represent the cross sections of three ties, the shaded portion being sapwood and the white, heartwood. The dotted lines show how these ties could be improved by slabbing the sides. If impregnated with creosote, the ties would appear as in Figures D, E, and F, showing the heavy impregnation on the sides and the very slight impregnation on the faces in Figures D and E. Figures G and H represent ties A and B slabbed on the sides and then impregnated with creosote, showing the even distribution of the preservative and the heavier injection on the faces than in B and D, thereby giving greater protection to the tie where it is most needed and at the same time consuming less of the preservative.

THE DIESEL ENGINE IN GREAT BRITAIN

IMPORTANCE OF THIS ENGINE IN AN EXCLUSIVELY COAL PRODUCING COUNTRY

Dr. Rudolph Diesel—Institution of Mechanical Engineers

GREAT Britain has had, at least until to-day, no natural liquid fuels of its own; it is an exclusively coal producing country. Based on these statements, it has often been seriously put forward in recent times that England has no interest in the Diesel engine, and that it is against her most vital interest to participate in the development of this engine, as she would neglect her wealth in coal, and make herself dependent on foreign markets when using liquid fuels. The Exhibition at Turin has shown clearly that England has still very little interest in the Diesel engine as far as stationary plants are concerned owing to her abundance of coal; for in the English Section, with the exception of some

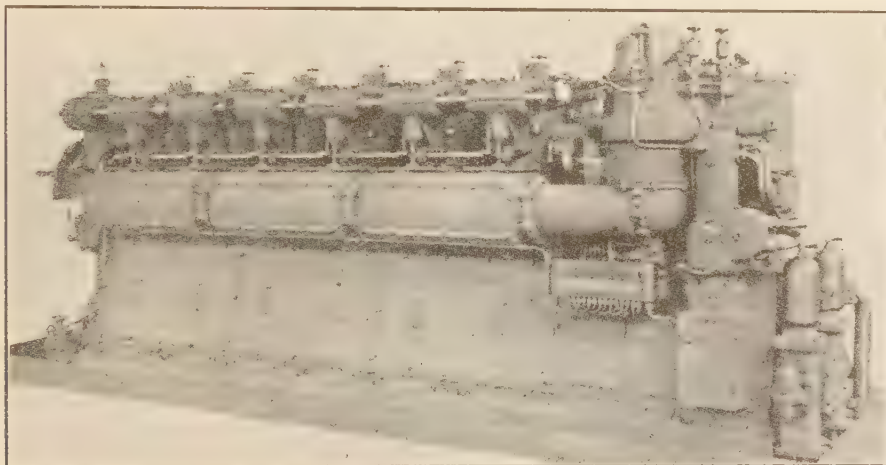
very small oil-engines, only generator-gas engines were exhibited; but these were numerous, of first-class workmanship, and were built by the best firms in the country. England has therefore made great progress in power generating with gas, while she has up to the present given relatively little attention to power generating with liquid fuels.

But the foregoing arguments in favor of coal are not correct; the contrary is true. England has the greatest interest in replacing the coal wasting steam engine by the more economical Diesel engine, and this, first, because she can therewith effect enormous savings in her most valuable treasure, coal, and thus defer the exhaustion of her stock; and, sec-

only, because she can run her coal industry and the independent chemical industries on more economical lines, when using the coal in the more rational and refined way for the generation of gas. Finally, because she will also make herself free and independent of foreign markets for the supply of liquid fuels by using coal in this way, that is, by working the tars and tar oils in the Diesel engine. It is not intended to imply that the whole demand of fuel for England could be produced in this

ally the determining factor. Further, the transport of these liquid fuels is considerably easier and more convenient than the transport of coal especially when tank vessels and pipe lines are used; and, finally, the difficulty of working a boiler plant will only occasionally come into consideration in the Colonies, especially in the interior, except, of course, for small plants using wood, straw, and the like.

It may be mentioned in this connection that a pipe line of about 250



SIX-CYLINDER MARINE ENGINE. 300 REVOLUTIONS PER MINUTE

way in the country itself, but through the inland production, increase of prices for foreign oils and the establishments of trusts and monopoly companies will be prevented. In this sense independence is meant.

It is not possible to foresee to-day what England can obtain for her Colonies from the Diesel engine; even when using only the natural mineral oils, the Diesel engine is the predestined colonial engine, because only about the fourth or sixth part of weight in fuel has to be transported for it to the colonies and their hinterlands, as compared with the steam engine. For a colonial engine the cost of freightage for fuel is gener-

miles in length for crude petroleum is being built on the river Congo from Matadi to Leopoldville, by means of which this extensive district will be supplied, in the simplest and cheapest way, with a constant flowing fuel source, from which navigation and the railways, agriculture as well as other industries, will get their elements of life, namely, motive power. This magnificent example ought to be followed in the English Colonies; it is not necessary to specify in detail the great importance of such an undertaking for them.

If one only considers that the Diesel engine can utilise vegetable oils, entirely new prospects are brought to

light for the cultivation and expansion of industry in the Colonies, which are for no other country of such eminent importance as for Great Britain; and this is where she ought to start as soon as possible. The Diesel engine can be worked with the Colonies' own resources, and thus, again, can influence to a great extent the further expansion of agriculture in districts where it is predominant. This sounds to-day somewhat like a dream, but the author ventures to prophesy, with full conviction, that this way of using the Diesel engine will one day be of the utmost importance.

Finally, Great Britain is the greatest shipping nation in the world. When the first successes of the Diesel engine, as a marine engine, were heard of in England recently, and it was published that already numerous small mercantile and war vessels were fitted with Diesel engines, and

the possibility of more important plants was mentioned, and when it was realized that larger ocean vessels were destined to be fitted with Diesel engines, and that even a warship with a very large Diesel was in construction, it provoked a great movement and excitement in Great Britain, which is still fresh in the mind. Moreover, the reports about successful voyages with Diesel vessels under very difficult weather conditions are already increasing in number. The captains who have had Diesel engines on their vessels report on the greatest security and comfort in working; shipbuilders publish the figures of their savings. It is unquestionable that one of the greatest evolutions of modern industry will be connected with this development of the Diesel engine, and that Great Britain, as the greatest shipping nation of the world, will derive the greatest advantages from it.

THE MISSISSIPPI FLOOD OF 1912

SOME OF THE CONDITIONS WHICH TEND TOWARD HIGH FLOODS

H. C. Frankenfield—Engineering News*

FLOODS in the Ohio and Mississippi rivers are usually similar in their origin, and the general history of one is the history of all as far as essential details are concerned. A cold, early winter, resulting in a frozen soil and the accumulation of a considerable supply of unmelted snow over the Ohio watershed, and a storm in February, almost always from the southwest, with accompanying heavy rains and high temperatures in the Gulf States and the Ohio Valley. The ice in the Ohio River gives way, the runoff from the heavy rains is increased on account of the frozen soil, and the melted snow adds

to the volume. If the rains are prolonged until late in March, the floods receive a further increase from the runoff of the upper Mississippi and Missouri rivers.

The flood of the present year has not differed greatly from preceding floods except in the fact that it occurred about a month later than usual. The months of January and February were cold, and deficient in precipitation. The first southwestern storm passed over the Gulf States and the Ohio Valley on March 11-12. At this time the rivers were moderately high on account of a rise in the Ohio River earlier in the month.

*Flood Expert in connection with the United States Weather Bureau.

Two more southwestern storms, with moderate rainfall but low temperatures, occurred on the 14th and 20th. These were followed by an excessive rainfall with high temperatures on the 23d, and a fall of snow over Missouri and Kansas. On the 28th there was another heavy storm, and still another immediately following on April 1st.

The accompanying chart shows the total precipitation for the month of March. This precipitation was from

ville was 0.5 foot above the flood stage of 35 feet. With the third storm on March 20-21, the Ohio River at Cairo, Ill., passed the flood stage of 45 feet, and a flood set in over the upper Ohio, reaching a stage of 28.1 feet, or 6.1 feet above the flood stage, at Pittsburg, on the morning of March 22. The crest stage at Cincinnati was 53.4 feet on March 27, and at Louisville 28.7 feet on March 29, by which time the stage at Cairo was 51 feet, and at Memphis, 38.1 feet, 3.1 feet



RAINFALL EAST OF THE CONTINENTAL DIVIDE FOR THE MONTH OF MARCH, 1912

two to four inches in excess of the normal amount over the lower Missouri, Ohio and Mississippi watersheds, and, on account of the frozen soil, a much larger percentage than usual ran into the rivers with probably an additional half inch from the melted snows.

The Ohio River began to rise immediately after the passing of the first storm on March 11-12. The first flood warnings, covering that portion of the Ohio River from Evansville, Ind., to Shawneetown, Ill., were issued on March 16, and on the morning of March 18, the river at Evans-

ville was 0.5 foot above the flood stage of 35 feet. With the fifth southwest storm of the month in progress.

The heavy snows that fell over Kansas and Missouri in March 23-24 had also melted, bringing the Missouri River east of Kansas City and the Mississippi from Saint Louis to Cairo almost to flood stage, and these waters contributed to materially increase the stage at Cairo and points below. With the arrival of the fifth storm on March 28-29, it became evident that the highest stages ever known would occur between Cairo and Memphis, and, as soon as the

sixth storm, that of April 1-2, had passed, it was stated by the Weather Bureau that all records would be exceeded between Cairo and the mouth of the Mississippi River. Above Cairo the floods were not of great consequence, and they were of general interest only so far as they affected the stages below.

The effects of levee construction upon the river stages were particularly noticeable at Memphis. At the time of the flood of 1897, when the flood volume was larger, the St. Francis levee from a point 106 miles above Helena, Ark., to Point Pleasant, Mo., and the left-bank levee from Hickman, Ky., to Tiptonville, Tenn., did not exist. The highest stage at Cairo in that year was 51.6 feet, and at Memphis 37.1 feet, a difference of 14.5 feet. In 1912, with the levees nearly complete on both sides of the river, the crest stage at Cairo was 54 feet, and at Memphis 45.3 feet, a difference of only 8.7 feet, or 5.8 feet less than in 1897.

This difference of between 8 and 9 feet in 1912 probably represents the actual gage relations now existing between Cairo and Memphis with unbroken levees, and indicates that the end has not yet been reached so far as extreme high stages are concerned. Before any of the levees gave way this year there was sufficient water in

sight to have caused a stage of 56 feet at Cairo, 2 feet higher than the stage actually reached, and 3.4 feet higher than the previous high-water mark of February 27, 1883.

This stage of 56 feet marks the capacity of the Cairo city levees, and, if it had occurred with the levees outside the city remaining intact, the crest stage at Memphis would certainly have been little, if any, under 48 feet, or 7.7 feet above the previous high-water mark of February 3, 1907. There would also have been a proportionate increase in the stages below Memphis.

Again, it must be remembered that this flood of 1912 came from the Ohio River and its tributaries. It is true that the lower Missouri and the upper Mississippi contributed somewhat, but the great bulk of the water came from the Ohio. The Arkansas River was in moderate flood only, while the Red River was not at all high. It is also true that there is no record of a flood in the lower Mississippi River caused by simultaneous floods in all of the large tributaries. As a rule, whenever the eastern tributaries were in great flood, the western ones failed, and *vice versa*, but the possibility of a combined flood is always present, and, if such a flood should come, the stages of 1912 would be exceeded below Cairo.

DORR THICKENERS WITH VACUUM FILTERS

THE SEPARATION OF RICH SOLUTIONS BY DECANTATION AFTER THINNING

J. Leslie Mennell—Mining and Engineering World.

EFFICIENCY in filters—vacuum or compression—is a very variable quantity, and depends entirely upon the physical properties of the slime handled. Slimes, even from a single district, will vary to such an extent, that while a given filter unit will perform efficient work

with some ores and handle a large daily tonnage, the same filter may not handle half that tonnage with a less adaptable ore, and, further, the efficiency of the separation and washing out of the rich values will prove most unsatisfactory.

With such slime it is necessary to

effect a separation of the rich solution from the slime residue by means other than filtration in vacuum filters. For such separation the author proposes a scheme for combining Dorr thickeners with vacuum filters to improve the filter plant efficiency.

There would be no deviation from present practice up to the discharge of the pulp from the Pachuca tanks. The pulp from the milling operations is thickened in Dorr thickeners, and the thick pulp with 1.5 tons of solution per ton ore, is passed to the Pachucas and there treated at that consistency. The Pachucas, of which there are four, are arranged in "continuous system."

The exhausted pulp issuing from the last of the series of Pachuca tanks, and having 1.5 tons of solution carrying 162 grams of silver per ton to each ton of ore is passed to a small tank or "thinner," in which the pulp is mixed and thinned down with 4.5 tons of mill solution which carries 48 grams of silver to the ton. The resulting thinned pulp, 6:1 consistency, in which the silver per ton in solution is diluted down to 76.5 grams per ton, is passed to a Dorr thickener. Here five-sixths of the solution, or 5 tons, is obtained as clear overflow and passed to the rich solution tanks for precipitation, and the thick pulp at 1:1 consistency drawn from the underflow. At this point a 68.5% separation of the silver in solution has been effected—the difference between 1.5 tons of solution assaying 162 grams per ton as it came from the Pachucas, and 1 ton of 76.5 grams silver per ton, as the pulp came from the first Dorr thickener. This extracted 68.5% of soluble silver value has gone to enrich a portion of the mill solution to a point where the precipitation of its value is necessary and economical; and

these 5 tons of solution constitute the entire tonnage—per ton of ore—of solution which goes to precipitation in the whole process.

The thick pulp from the first Dorr thickener passes on to a second "thinner," where it is again thinned, but this time with 5 tons of barren solution, so that the pulp issues from the "thinner" with 6 tons of solution containing 14.4 grams silver per ton to each ton of ore. This pulp passes to Dorr thickener No. 2, where five-sixths, or 5 tons, of clear solution is overflowed to "enriched barren solution sump," whence it is pumped back to the ordinary mill solution sump, and mixes with the ordinary mill solution serving to impoverish same. The thick pulp drawn from the second Dorr thickener, at 1:1 consistency, has now had extracted 94% of its soluble value, being the difference between the 1.5 tons issuing from the Pachucas with 162 grams of silver per ton, and 1 ton of solution associated with this pulp carrying 14.4 grams per ton. Only 5 tons of solution have had to be pumped in the scheme—the barren solution—as the mill solution used in the thinning before passage to the first Dorr thickener naturally ran to the thinner by gravity.

The thick pulp resulting from the two operations in the Dorr thickeners and which now contains only 6% of the soluble value associated with its ore, is passed by way of the filter head tank to the Butters vacuum filter and filtered in the usual way. In the formation of the cakes, supposing them to contain 33% solution as "moisture" after completion, about one-half or 50% of the associated solution is extracted by the process. The cakes are given a simple water wash with the object of displacing as far as possible the associated cyanide

with water, and also getting in that process as much of the few remaining grams of dissolved silver as possible. Were the efficiency of this wash only 50%, then the wash would leave one-quarter ton of the cyanide solution, which would amount to 3.6 grams of soluble value left in the discharged—dry—cakes, or a total extraction of 98.5% of the soluble value in the complete scheme of operations—the exact amount obtained in the vacuum operations being 4.5%.

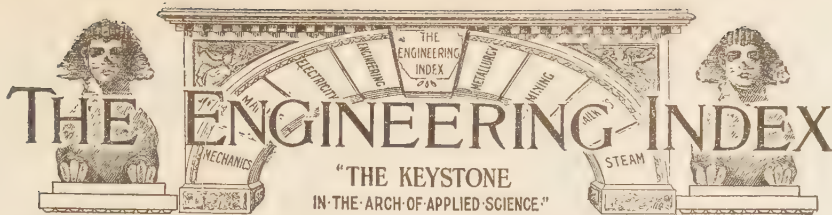
In the above combination process of separating the rich solutions from the residue ore by two decantations in succession through Dorr thickeners, followed by filtering in a Butters filter with only a water wash through the cakes—the latter calculated at only 50% efficiency—it will be seen that a 98.5% extraction of the soluble silver in the pulp is obtained, or the dissolved silver value left in the cakes upon discharging amounts to 3.6 grams of silver per ton of dry ore. The recovery of the cyanide is precisely the same as in ordinary vacuum filter methods.

It will be noted from the above that this scheme of treatment enables a very satisfactory extraction of the soluble silver values from the pulp to be obtained; and that it is also satisfactory when very slimy ores are handled which are not amenable to efficient washing in a vacuum filter.

The following advantages will be obtained by the scheme:

1. The extraction of almost all the dissolved silver—94% from the pulp, as rich solution, before passage of the pulp to the filter plant; an important result, in the case of ores which form slimy unwashable cakes.
2. The increased capacity given to the filter plant because of the lack of necessity for a barren solution wash, which in the case of the Butters plant saves time in the filter cycle, and in the case of the Moore plants saves the barren solution tank, and enables it to be effectively used with another set of leaves for forming cakes.
3. The handling in most cases of a lesser tonnage of solution in the precipitation boxes than with the ordinary practice. This for the reason that the only solution sent to the precipitation boxes is the 5 tons "of enriched mill solution," while the solutions sucked out in the filter operations, and also those coming from the second Dorr thickener, are so low grade as to always go to the mill sump.
4. Great elasticity and therefore continuity of operations. This is because the Dorr thickeners can be shut off a couple of hours, or two Dorr thickeners for 4 hours, in case the filter plant is delayed, without interrupting the flow from the Pachucas, and without a dirty overflow from the Dorrs. As the flow will be thickened from the Dorrs when again started, the advantage is gained both ways.

On the other hand, in the working of the process, there is required a little more pumping than at present, amounting to about 4.5 tons per ton of ore, and to a height a little exceeding that of two Dorr thickeners, or say at the most 35 feet. This is partly offset by not having to pump some 2 tons of barren solution through the vacuum filter, and so really amounts to very little if any additional expense.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

- (1) The title of the article,
- (2) The name of its author,
- (3) A descriptive abstract,
- (4) Its length in words,
- (5) Where published,
- (6) When published,
- (7) *We supply the article itself, if desired.*

 The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes’ time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one’s special interest.

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CIVIL ENGINEERING

BRIDGES

Arches

The Advantages of Suspended Centering for Arch Erection. H. G. Tyrrell. Considers methods and their advantages. 3000 w. Engng & Con—April 24, 1912. No. 32328.

The Construction and Moving of a Large Center. Moriz Bernstein. Illustrated detailed description of methods used in the construction of the Walnut Lane rubble concrete bridge over the Wissahickon Creek, Philadelphia, Pa. 3500 w. Jour Am Soc of Engng-Con—March, 1912. No. 32147 C.

Cantilevers

Through and Plate-Girder Spans of the Susquehanna River Bridge. Illustrated detailed description of a new double-track B. & O. bridge at Havre-de-Grace, Md. 2000 w. Eng Rec—April 20, 1912. No. 32189.

Competition

The Close Competition in Plans for the Contract of Constructing a Four-Track Bridge over the Neckar at Cannstatt (Der engere Wettbewerb zur Erlangung von Entwürfen und zur Vergebung der Bauarbeiten für die viergleisige Eisenbahnbrücke über den Neckar bei Cannstatt).

We supply copies of these articles. See page 503

Herrn Jori and Schaechterle. Presents some of the plans submitted. Ills. Serial. 1st part. 2200 w. Beton u Eisen—Apr. 1, 1912. No. 32024 E.

The Competition for a Highway Bridge over the Rhine at Cologne (Der Wettbewerb um den Entwurf einer Strassenbrücke über den Rhein bei Köln). K. Bernhard. The second of a series of articles giving outlines of plans submitted. Ills. Serial. 2nd part. 6600 w. Zeitschr des Ver deutscher Ing—Apr. 6, 1912. No. 32050 D.

Culverts

See same heading under *Roads and Pavements*.

Design

Specifications for the Design of Bridges and Subways. Continued discussion of Henry B. Seaman's paper. 4500 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32384 F.

Drawbridge

A Four-Track, Center-Bearing, Railroad Draw Span. Louis H. Shoemaker. Illustrations, with brief description of a special type of construction at Conneaut Harbor, Ohio, on the Bessemer & L. Erie R. R. 600 w. Pro. Am. Soc of Civ Engrs—March, 1912. 32129 F.

Erection

O.-W. R. & N. Ry Bridges Over the Burnt River. R. W. Parkhurst. Describes the geography of eastern Oregon, and the conditions affecting the construction of two bridges about 1000 ft. apart. Ills. 2500 w. Cornell Civ Engr—April, 1912. No. 32186 C.

The Celilo Bridge. Ralph Modjeski. Illustrated detailed description of the construction of a bridge consisting of 2110 ft. of plate girder spans, on the Oregon Trunk Line, explaining methods of erection. 8 plates. Discussion. 3500 w. Jour W Soc of Engrs—March, 1912. No. 32125 D.

Erecting the Last Span of the Municipal Bridge, St. Louis. Describes rapid work made necessary by the danger of the ice breaking and carrying away the false-work. Ills. 1000 w. Eng Rec—April 13, 1912. No. 31951.

Floors

Types of Shallow Floors for Railroad Bridges. O. F. Dalstrom. Deals with the difficult problem of designing satisfactory shallow bridge floors. Discussion. 7 plates. 6000 w. Jour W Soc of Engrs—March, 1912. No. 32127 D.

Glasgow

Cross-River Communication at Glasgow. Map, with explanation of conditions and present facilities, with an account of proposed schemes for improving transport. 3000 w. Engng—March 29, 1912. No. 31889 A.

Highway

Highway Bridges and Culverts. Charles H. Hoyt and William H. Burr. General

review of fundamental principles that govern properly designed highway bridges and culverts, stating facts relating to their construction. Ills. 21 pages. U S Dept of Agri, Bul. 43—April 6, 1912. No. 32156 N.

Iron Truss

An Old Iron Truss Bridge, 1853-1912. Illustrated description of bridge near Wakefield, N. Y., near New York City. 1500 w. Eng News—April 25, 1912. No. 32366.

Plate-Girders

See Cantilevers and Erection under BRIDGES.

Quebec

The North Main Pier of the Quebec Bridge. Plan of the works and illustrated description of the construction plant and methods. 2000 w. Engr, Lond—April 12, 1912. No. 32282 A.

Reconstruction

Widening a Pittsburg Bridge. Describes work on the old Smithfield St. bridge across the Monongahela River. Ills. 3500 w. Eng News—April 11, 1912. No. 31937.

The Work of Enlarging the Bridges Across the Seine at Puteaux and Neuilly-St. James (Note sur les Travaux d'Élargissement des Ponts sur la Seine a Puteaux et a Neuilly-Saint James). M. Caldagnès. Illustrated description of the work. Plates. 4000 w. Ann des Ponts et Chaussées—Jan.-Feb., 1912. No. 32079 E + F.

Reinforced Concrete

A Six-Track Railroad Bridge over Humphrey Street at New Haven. Illustrated description of a reinforced concrete structure built in sections without causing any interruption of the train service. 2200 w. Eng Rec—April 13, 1912. No. 31953.

The Iller Bridge at Martinszell in Algäu (Die Illerbrücke bei Martinzell im Algäu). Hermann Goebel. Details in the construction of a reinforced concrete bridge to replace previous structure destroyed by floods. Ills. 1700 w. Beton u Eisen—Apr. 1, 1912. No. 32022 E.

The Résorgimento Bridge across the Tiber at Rome (Le Pont du Résorgimento, sur le Tibre, a Rome). Louis Quesnel. Description of bridge, pier foundation, approaches, mode of applying reinforcing, rapidity of construction, etc. Ills. and Plates. 8000 w. Ann des Ponts et Chaussées—Jan.-Feb., 1912. No. 32077 E + F.

Removal

Moving the Passaic River Bridge at Newark, N. J. Illustrated account of the rapid shifting on scows of a double-track 212-foot span in service. 1600 w. Eng Rec—April 20, 1912. No. 32196.

Steel

Systems of Construction of Modern Steel Bridges (I sistemi di costruzione dei moderni ponti in ferro). U. Conte.

Review of some of the construction features in recent large bridges. Ills. 4000 w. *Ann della Soc d Ing e d Arch Ital*—Mar. 16, 1912. No. 32305 E.

Stresses

Relation of Heavy Mallet Locomotives to Bridge Stresses. Information from recent inquiries of roads using Mallet engines. 1200 w. *Eng News*. April 18,

Viaducts

The Weston Road Concrete Viaduct at Toronto. Illustrated description of a reinforced concrete viaduct approaching a steel truss span which carries this road over the Canadian Pacific R. R. tracks. 1200 w. *Eng Rec*—April 20, 1912. No. 32197.

The Connellsville Double-Track Viaduct. Illustrates and describes a long solid-floor plate-girder structure with arched masonry piers built jointly by two railroads. 2000 w. *Eng Rec*—April 6, 1912. No. 31821.

Winnipeg

The Red River Bridge for the National Transcontinental Railway. A general illustrated description of the more important features in the design and construction of this double-track bridge at Winnipeg. 3500 w. *Can Engr*—April 18, 1912. No. 32227.

CONSTRUCTION

Buildings

A Reinforced Concrete County Court House. Illustrates and describes details of a new court house in Fulton Co., Ga. A 9-story structure with concrete pile foundations and framing and roof trusses built of reinforced concrete. 1700 w. *Eng Rec*—April 20, 1912. No. 32192.

A Reinforced Concrete Sky-scraper in Stockholm (Ein Wolkenkratzer aus Eisenbeton in Stockholm). L. E. Hellstedt. Details of construction of twelve-storied combined office and apartment building. Ills. 1100 w. *Beton u Eisen*—Apr. 1, 1912. No. 32023 E.

Construction of the Department Store "Mariahilfer Zentralpalast" (Bau des Warenhauses "Mariahilfer Zentralpalast"). Hans Mikula. Details of the construction of a novel circular ladies' department store from wood and reinforced concrete in Vienna. Ills. Serial. 1st part. 2200 w. *Beton u Eisen*—Apr. 1, 1912. No. 32021 E.

Columns

Tests of Columns: An Investigation of the Value of Concrete as Reinforcement for Structural Steel Columns. Arthur N. Talbot and Arthur R. Lord. Investigations to obtain information upon the action of such columns. Ills. 44 pages. *Bul Univ of Ill*, No. 56—March 4, 1912. No. 32155 C.

Concrete

Practical Concrete Construction—Arriving at Cost Figures. De Witt V.

Moore. A study, with particular regard for costs and efficient methods of construction. 5000 w. *Cement & Engng News*—April, 1912. No. 31957.

Methods and Plant Employed for Mixing and Placing Concrete for Floors, Rand McNally Building, Chicago. Brief description. 1200 w. *Engng & Con*—April 3, 1912. No. 31793.

A City of Poured Houses. Illustrated description of the new system of building invented by Milton Dana Morrill, and used extensively at Nanticoke, Pa. 800 w. *Sci Am Sup*—April 27, 1912. No. 32336.

See also Gasholders, Warehouses and Waterproofing, under *Construction*.

Concrete Repairing

Methods of Patching and Repairing Plain and Reinforced Concrete. Abstract of the report of the Committee on Masonry of the Am. Ry. Engng. Assn. 3500 w. *Eng News*—April 25, 1912. No. 32368.

Construction Camps

The Sanitation of Contractors' Camps and the Patrol of Watersheds. A. J. Provost, Jr. Describes the sanitary work carried out by the contractors of the N. Y. City water supply; William W. Locke reports concerning Wachusett reservoir, in the Metropolitan water supply of Boston; and H. G. Payrow refers briefly to the Morris Dam, Waterbury, Conn. Ills. 4500 w. *Jour Assn of Engng Ins*—March, 1912. No. 31784 C.

Contracts

Interpretation of Documents Composing Engineering Contracts. Jerome Cochran. Considers seriatim the essential documents to a complete engineering contract. 7500 w. *Cornell Civ Engr*—April, 1912. No. 32187 C.

Drainage

See same heading under *Waterways and Harbors*.

Earthquake Construction

Seismic Construction (Le costruzioni asismichi). M. Viscardini. Discussion on the several theories of construction against earthquakes. Diagrams. Serial. 1st part. 2500 w. *Il Cemento*—Mar. 30, 1912. No. 32308 D.

Electric Power

Electric Power in Building the World's Greatest Aqueduct. J. M. Matthews. Shows that electric power has been almost indispensable in the construction of the Catskill Aqueduct and the Panama Canal. Ills. 4000 w. *Gen Elec Rev*—April, 1912. Serial. 1st part. No. 31865 C.

Electricity in Stone Quarries and Gravel Pits. Illustrated description and information concerning plants near Chicago. 4500 w. *Elec Rev & W Elect'n*—March 30, 1912. No. 31686.

Fireplaces

Fireplace Designed for Heating Purposes. Illustrates and describes details of construction intended to throw heat out

into the room. 900 w. Met Work—April 12, 1912. No. 31919.

Floors

Stress Measurement of a Loaded Tile-Concrete Floor Slab. From a paper by Frank J. Trelease, read before the Nat. Assn of Cement Users. Explains method of testing and gives results. 1500 w. Eng Rec—April 20, 1912. No. 32195.

A New Type of Flooring (Die un nuovo tipo di solaio). Eug. Carini. Description of a reinforced tile arch for fireproof construction in floors and roofs. Ills. 2500 w. Il Cemento—Mar. 15, 1912. No. 32307 D.

See also same heading under *Bridges*, and Reinforced Concrete Slabs under *Materials of Construction*.

Foundations

Concrete Column Foundation for a Building Over Coal Mine Workings. Describes an unusual foundation used in constructing a high-class residence in Pittsburgh over old coal mines. Ills. 800 w. Eng News—April 4, 1912. No. 31800.

The Method of Excavating the Cellar of the Woolworth Building in New York. Illustrates and describes methods used in excavating to an average depth of 115 ft. below the curb in the foundation work of a 55-story building. 1500 w. Eng Rec—April 27, 1912. No. 32394.

Substructure of the Guaranty Trust Building, New York. Brief account of pneumatic caisson foundations carried through quicksand to a depth of 60 to 90 ft. below the curb. 1800 w. Eng Rec—April 20, 1912. No. 32199.

Gas-Holders

Engineering Features of a Large Gas-Holder. Herbert W. Alrich. Illustrates and describes the design and construction of a 10,000,000 cu. ft. holder at New York. 6500 w. Eng Rec—April 27, 1912. No. 32386.

The Suitability of Concrete for Gas-holder Tanks. Herbert W. Alrich. Describes the mechanical features of gas-holders and discusses requirements in America. Enumerates the disadvantages of concrete over steel. 3500 w. Am. Gas Lgt Jour—April 29, 1912. No. 32433.

Hospitals

The Small Infirmary (Das kleine Krankenhaus). Max Setz. Notes on the advisability of constructing small hospitals of fifty beds or under, and details on ideal designs for such. Ills. Serial. 1st part. 4400 w. Zeit d Oest Ing und Arch Vereines—Mar. 8, 1912. No. 32052 D.

Monuments

The Victor-Emmanuel II. Monument at Rome (Le Monument de Victor-Emanuel II., a Rome). Fr. Pollastri. Details in the construction and erection of this large monument. Ills. and Plate. 3000 w. Genie Civil—Mar. 16, 1912. No. 32097 D.

Pile Driving

Self-Propelled Pile Driving Plant. Illustrated description of a locomotive steam pile driving plant designed for the Argentine Ry. Co. 500 w. Engr, Lond—March 22, 1912. No. 31733 A.

Reclamation

Engineering Achievements in Land Reclamation. Victor H. Powers. Illustrated account of how 188,000 acres are being redeemed at Fellsmere, Florida. 3000 w. Mfrs' Rec—April 11, 1912. No. 31947.

See also Drainage, under *Waterways and Harbors*.

Store-Keeping

The Material-List Method of Store-Keeping. R. W. Heafield. Explains the main features of this system and its advantages. 1700 w. Can Engr—Apr. 11, 1912. No. 31959.

Tank Failure

Failure of an Air-Pressure Water Tank at Jessup, Iowa. Brief illustrated account. 1000 w. Eng News—April 18, 1912. No. 32213.

Tunnels

Air Resistance to Trains in Tube Tunnels. J. V. Davies. Gives results of experimental tests and deductions drawn. Ills. 9000 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32380 F.

Methods and Costs of Constructing Two Rock Tunnels Under the Erie Canal for the Buffalo, N. Y., Water Works. C. H. Hollingsworth. Illustrates and describes the construction methods. 3000 w. Engng & Con—April 17, 1912. Serial. 1st part. No. 32144.

Notes on a Tunnel Survey. Discussion of the paper by Frederick C. Noble. Plates and Ills. 3500 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32134 F.

Notes on a Tunnel Survey. Continued discussion of paper by Frederick C. Noble. Ills. 2500 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32383 F.

The Laramie-Poudre Tunnel. Burgis G. Coy. Illustrated detailed description of this important feature of an irrigation project in Colorado. 4000 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32130 F.

Notes on the Laramie Tunnel. David W. Brunton. Illustrated detailed account of the construction of this tunnel driven to convey water from the Laramie to the Cache-la-Poudre for use in irrigation. 5200 w. Bul Am Inst of Min Engrs—April, 1912. No. 32413 F.

Underpinning

Underpinning of the Brooklyn Academy of Music. Describes supports found necessary for safety during subway excavation. Ills. 1500 w. Eng Rec—April 6, 1912. No. 31817.

Warehouse

Construction of a Concrete Pier Shed on a Cotton Dock at Galveston. J. L. Jacobs. Illustrated description of a fire-

proof warehouse. 1800 w. Eng Rec—April 13, 1912. No. 31954.

Waterproofing

Waterproofing Concrete Floors of Bridges. A. H. Rhett. States the problem and considers the fundamental principles to its solution. 1800 w. Eng Rec—April 13, 1912. No. 31952.

MATERIALS OF CONSTRUCTION

Cement

The New Tidewater Portland Cement Plant at Union Bridge, Maryland. Illustrates and describes large mills using individual motors for the operating machinery. 3500 w. Eng Rec—April 13, 1912. No. 31955.

The Essential Hydraulic Elements in Calcareous Cement (*L'idraulite elemento essenziale dei cementi calcarei*). F. Ferrari. Discussion on the chemical components of cement. Serial. 1st part. 1800 w. Il Cemento—Mar. 30, 1912. No. 32309 D.

Slag Portland Cement in Comparison with Portland Cement (*Eisenportlandzement im Vergleich zu Portlandzement*). H. Passow. Results of various tests on the comparative strength of these two products. 2100 w. Stahl u Eisen—Mar. 21, 1912. No. 32011 D.

The Future of the Rotating Furnace in Hainault (*L'Avenir du Four Rotatif dans le Hainaut*). Louis Wuyts. A study of artificial Portland cement produced in rotating furnaces. 3000 w. Tech Mod—Apr. 1, 1912. No. 32093 D.

Concrete

See same heading under *Construction*; and *Ligno-Concrete*, under *Materials of Construction*.

Ligno-Concrete

Ligno-Concrete. Gerald O. Case. Report of investigations made to determine whether concrete could be efficiently and economically reinforced by timber. 5500 w. Soc of Engrs—April 1, 1912. No. 32153 N.

Lumber

The Economical Piling of Lumber. James F. Hobart. Suggestions for the best and quickest way. Ills. 2000 w. Wood Craft—April, 1912. No. 31787.

Nails

Nails (*Le Clou*). Ch. Frémont. Historical sketch on the origin, uses, and manufacture of nails from the earliest known times to the present. Ills. Serial. 1st part. 29 pages. Bull Soc d'Encouragement—Feb., 1912. No. 32085 G.

Reinforced Concrete

Unit Costs of Reinforced Concrete for industrial Buildings. Chester S. Allen. Read before the Nat. Assn. of Cement Users. Information based on work during the past two years. 2000 w. Can Engr—March 28, 1912. No. 31683.

Testing of Materials Used in Reinforced Concrete. A. Alban H. Scott. From a paper read before the Soc. of

Archts. Outlines a procedure recommended. Also discussion. 7000 w. Builder—March 22 and 29, 1912. Serial. 2 parts. No. 31868 each A.

Elastic Deformation Tests on Reinforced-Concrete Buildings. Abstracts from report of tests made under the auspices of the Nat. Assn. of Cement Users, indicating the nature of the work and its value. 6000 w. Eng News—April 18, 1912. No. 32209.

Detailing Reinforced Concrete. Jerome Cochran. An attempt to outline rules which will help toward uniform practice. 8500 w. Eng News—April 4, 1912. No. 31799.

A New Type of Steel and Concrete Construction. Describes a type of construction being employed in the First Baptist Church of Syracuse, N. Y. Ills. 1200 w. Eng Rec—April 27, 1912. No. 32391.

See also same heading, under *Bridges*; *Building*, under *Construction*; *Purification*, under *Water Supply*; *Piers*, under *Waterways and Harbors*; *Stamp Foundations*, under *MINING AND METALLURGY*; *Ore Dressing and Concentration*, and *Pumping Stations and Tanks*, under *RAILWAY ENGINEERING*, *Permanent Way and Buildings*.

Reinforced Concrete Beams

The Strength of Reinforced Concrete Beams; Results of Tests of 333 Beams. (First Series.) Richard L. Humphrey and Louis H. Losse. Tests on the behavior of reinforced concrete beams under load, as influenced by the character of the concrete, arrangement and percentage of reinforcement. Ills. 200 pages. Bull Bur of Standards, June 27, 1911. No. 32290 N.

Calculations on Reinforced Concrete Beams (*Note sur le Calcul des Poutres en Béton Armé*). M. Hachon. Studies on beams under compression when the neutral fibre falls within the beam. 4800 w. Ann des Ponts et Chaussées—Jan.-Feb., 1912. No. 32078 E + F.

Reinforced-Concrete Slabs

A Method of Analyzing Radially Reinforced Flat Slabs. S. E. Slocum. Gives the chief features in the design and analysis of stress for this method of reinforcement. 2000 w. Eng News—April 18, 1912. No. 32210.

Analytical Tests of Beam and Girder Floors. Report of the Committee on Reinforced Concrete of the Nat. Assn. of Cement Users, presenting tests made on actual buildings under load, with discussion of methods of testing. Ills. 5000 w. Cement Age—April, 1912. No. 32299.

The Practical Design of Reinforced Concrete Flat Slabs. Sanford E. Thompson. Read before the Nat. Assn. of Cement Users. Considers the designing of flat slab floors for reinforced concrete structures. 3000 w. Can Engr—March 28, 1912. Serial. 1st part. No. 31681.

Sand

Testing Sand for Use in Concrete and Cement Mortar. Cloyd M. Chapman. Outlines the method used in the laboratory of Westinghouse, Church, Kerr & Co. 3000 w. Eng Rec—April 27, 1912. No. 32390.

Specifications

American Society for Testing Materials. Report of the 13 new and 3 revised iron and steel specifications proposed at the last meeting. 4000 w. Ir Age—April 4, 1912. No. 31764 C.

Timber Preservation

Wood Preservation. James D. MacLean. Brief discussion of the processes and problems. 2500 w. Wis Engr—April, 1912. No. 32410 C.

The Zernsdorf Tie Impregnation Plant (Die Schwellentränkanstalt Zernsdorf). Herr Matthaei. Description of plant and the methods of treatment. Ills. Serial. 1st part. 5500 w. Glasers Ann—Apr. 1, 1912. No. 32033 D.

MEASUREMENT**Drain Tile Testing**

A Method of Making Tests on Drain Tile. Prof. A. N. Talbot and D. A. Abrams. Read before the Nat. Assn. of Cement Users. Illustrated description of a machine designed for such tests. 2000 w. Eng Rec—April 6, 1912. No. 31823.

Flexure

Faults in the Theory of Flexure. Henry S. Prichard. A study of the nature and influence of the faults of the theory. Ills. 6000 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32131 F.

Hydraulic Formulae

Some of the Inexact Hydraulic Formulae (Sur Quelques Formules Inexactes de l'Hydraulique). D. Banki. Mathematical discussion showing the cause of inexactness in some formulae, and how they can best be approximated without causing errors. Ills. 8400 w. Rev de Mecan—Feb., 1912. No. 32087 E + F.

The Present Standing of Hydraulic Science (Der gegenwärtige Stand der Hydraulik). Prof. A. Budau. Reviews some of the more recent hydraulic theories. Ills. and plate. Serial. 1st part. 2800 w. Zeit d Oest Ing u Arch Ver—Mar. 29, 1912. No. 32055 D.

Photo-Surveying

Stereographic Measurement. G. R. Anderson. Discusses the use of photographs in surveying, dealing with the question of measurement only. 1500 w. Can Engr—March 28, 1912. No. 31680.

Photo-topography and Photogrammetry (La Phototopographie et la Photogrammetrie). Paul Helbronner. Applications of photography for the survey of mountainous regions. Ills. 5600 w. Genie Civil—Mar. 9, 1912. No. 32095 D.

Stream Gauging

See Weirs, under *Water Supply*.

Surveying

Retracement-Resurveys — Court Decisions and Field Procedure. Discussion of N. B. Sweitzer's paper. 3500 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32137 F.

The Land Survey of the Canal Zone. P. H. Underwood. Describes the more important features of a survey recently completed by the Isthmian Canal Commission. 3000 w. Cornell Civ Engr—April, 1912. No. 32185 C.

A New Stadia Attachment and Diagram. R. L. McCormick. Illustration, with explanation of the mathematical principles involved, of an instrument devised by the author. 1200 w. Eng News—April 25, 1912. No. 32370.

The Main Levelling of Copenhagen, 1907-8. C. F. V. Boock. The present number explains the bench marks and manner of placing them, the instruments and appliances used, etc. 4000 w. Surveyor—April 12, 1912. Serial. 1st part. No. 32262 A.

See also Photo-Surveying, under *Measurement*.

MUNICIPAL**City Planning**

Landscap Art and City Design. Malcolm N. Ross. Read before the Arts and Literature Soc., Saskatoon. Discusses the subject of city design, and the recent movement to improve and beautify cities. 3500 w. Can Engr—March 28, 1912. No. 31682.

City Planning. John M. Lyle. Discusses in detail eight principal points to be considered, and the importance of a fixed policy. 4500 w. Ap Sci—March, 1912. No. 31782 C.

Climbing

Making the Public Work. Reginald Pelham Bolton. A study of the physical burden of climbing in buildings and thoroughfares. 3000 w. Cassier's Mag—April, 1912. No. 31835 B.

Gas Illuminating

State and Municipal Regulations for the Quality, Distribution, and Testing of Illuminating Gas. The methods employed at present in the United States. 133 pages. Bureau of Standards, Circ. No. 32—April 1, 1912. No. 32297 N.

Refuse Destructors

Colombo's Refuse Destructor. Clive H. Kilmister. Read before the Ceylon Engng. Assn. Illustrated description of the plant and its operation. 3500 w. Surveyor—April 12, 1912. No. 32263 A.

Sewage Disposal

Sewage Purification. Rudolph Hering. Address before the Univ. of Toronto Engng Soc. Reviews the history of its development and outlines what are at present considered the principles upon which sewage purification is based and its disposal without offense. 5000 w. Ap Sci—April, 1912. No. 32405 C.

The Private Sewage Disposal Plant. Dr. Jacolyn Van Vliet Manning. Illustrated description of system adopted for the detached villa, farm or country house. 1500 w. *Sci Am*—April 13, 1912. No. 31948.

Construction Cost of the Sewage Purification Works at Washington, Penn. Donald M. Belcher. Gives the cost of the different structures, with outline of the work. 1500 w. *Eng News*—April 11, 1912. No. 31938.

A Sewage-Disposal Plant for Attaining a High Degree of Purification. Illustrates and describes a plant at Pleasantville, N. Y., for the Hebrew Sheltering Guardian Society. 2500 w. *Eng Rec*—April 6, 1912. No. 31824.

The Sewage Purification Plant at Ligonier, Pennsylvania. Illustrates and describes details of a plant having Imhoff tanks, compressed-air ejectors, sprinkling filters, and hypochlorite disinfecting apparatus. 2200 w. *Eng Rec*—April 20, 1912. No. 32194.

Sewage Pumps

See Pumps, under MECHANICAL ENGINEERING, *Hydraulic Machinery*.

Sewage Records

The System of Recording Sanitary Sewer Notes in Use at Dayton, Ohio. F. O. Eichelberger. Describes a comprehensive yet concise system. 1200 w. *Engng & Con*—April 10, 1912. No. 31911.

Sewers

Specifications for the Manufacture, Testing, Dimensions and Laying of Plain Concrete Sewer Pipe, Kansas City, Mo. Gives specifications drawn by L. R. Ash, city engineer. 1800 w. *Engng & Con*—April 17, 1912. No. 32146.

The New Sewer Standards of Richmond, Va.—Dimensions of Trenches—Instructions to Inspectors. Allen J. Saville. Gives standard plans drawn to improve the quality of the work and secure uniformity in construction. Ills. 1600 w. *Engng & Con*—April 17, 1912. No. 32145.

Methods and Cost of Flushing Sewers. An illustrated economic study of this subject. 2200 w. *Engng & Con*—April 24, 1912. No. 32325.

Smoke

The Smoke Abatement Conference. Abstracts of papers read in London, showing what is being done in different localities. 3000 w. *Power*—April 30, 1912. No. 32487.

Smoke Abatement. Dr. John S. Owens. Read before the British Assn. Discusses the possibility of establishing a new standard of smoke emission for factory chimneys. 4000 w. *Can Engr*—April 18, 1912. No. 32322.

The Influence of Smoke on Decorations. Noel Heaton. Read at Coal Smoke Abatement Conf., London. Examines effects that have come under the author's experience. The effect on stained glass, paint-

work, fresco paintings, etc. 1500 w. *Archit, Lond*—March 29, 1912. No. 31870 A.

The Action of Coal Smoke on Building Stones and Mural Paintings. Sir Arthur Church. Read at Coal Smoke Abatement Conf., London. Describes coal smoke and its harmful constituents and their effects. 1500 w. *Archit, Lond*—March 29, 1912. No. 31871 A.

The Effect of Coal Smoke on Buildings. Harry Redfern. Read at Coal Smoke Abatement Conf., London. Mainly discussed from the viewpoint of the architect. Also considers what is being done to mitigate the evils. 2500 w. *Archit, Lond*—March 29, 1912. No. 31869 A.

ROADS AND PAVEMENTS

Bituminous

Bituminous Roads and Pavements and Their Materials of Construction. Prevost Hubbard. Discusses some of the fundamental principles, the selection of materials, methods of construction, etc. 7000 w. *Jour Fr Inst*—April, 1912. No. 32163 D.

Brick

Strain Measurements of Brick Pavements. James E. Howard. Read before the Nat. Brick Mfrs.' Assn. Reports physical tests, effects of street cars and of temperature variations, etc. Ills. 2500 w. *Munic Jour & Engr*—April 4, 1912. No. 31795.

Concrete

Concrete Pavements at Ann Arbor. E. W. Grons. From a paper before the Nat. Assn. of Cement Users. Gives results of experience with combined concrete and asphalt pavements. 2000 w. *Eng Rec*—April 27, 1912. No. 32388.

Construction

Science in the Service of Highway Construction. Clifford Richardson. Outlines the development of the modern methods of highway construction, and shows how science has aided. 5000 w. *Pop Sci M*—April, 1912. No. 31726 C.

Road Construction and Maintenance. An informal discussion of fillers for brick and block pavements, of bituminous surfaces, methods, etc. 7500 w. *Pro Am Soc of Civ Engrs*—March, 1912. Serial. 1st part. No. 32138 F.

Crowning

Current Practice in Fixing Pavement Crowns. Daniel B. Goodsell. Describes methods used, effect of car tracks, and conclusions. 1200 w. *Engng & Con*—April 24, 1912. No. 32324.

Culverts

Culvert Practice in Road Building in Connection with Drainage Ditching in Minnesota. Extracts from a paper by W. R. Hoag, read before the Minn. Soc. of Survs. & Engrs. Gives valuable data on culvert practice. Ills. 1000 w. *Engng & Con*—April 24, 1912. No. 32327.

Dust

Proposals for Dust Suppression and Road Improvement. Dr. Guglielminetti.

Read before the Swiss Motor Club. Discusses conditions in Switzerland and how to meet the expense for needed road improvements. 2200 w. *Can Engr*—April 18, 1912. No. 32231.

England

The Main Roads of England. Describes their methods of construction and repair, with special reference to the bad condition of the Great North road and the North-Western highways. Ills. 3000 w. *Auto-car*—March 30, 1912. No. 31873 A.

Materials

Principles Involved in the Selection of Street Pavement. Abstract of a report prepared by James E. Barlow and Rufus E. Miles, and issued by the Bureau of Municipal Research of Cincinnati, O. 1500 w. *Engng & Con*—April 10, 1912. No. 31910.

Tar

Changes Noted in a Tar Exposed to Traffic and Weathering When Used in a Road Surface. W. W. Crosby. Report of an investigation made. 1800 w. *Surveyor*—April 5, 1912. No. 31987 A.

Wood Block

The Creosoted Wood Block Pavements of Chicago Loop District—A Review. William W. Marr. An illustrated review of the work. 5500 w. *Engng & Con*—April 10, 1912. No. 31909.

WATER SUPPLY

Dam Failures

The Failure of the Dam of the Erindale Power Company. Francis F. Longley. Brief account of this failure of an earth dam with core-wall of concrete masonry, in Ontario. 1100 w. *Eng Rec*—April 27, 1912. No. 32387.

The Failure and Repair of the Winston (N. C.) Water Works Dam. J. N. Ambler. Illustrated description with information concerning the disaster and means adopted for repairing. 2000 w. *Eng News*—April 11, 1912. No. 31934.

The Failure of a Dam on Owasco Lake. A letter from J. Walter Ackerman, with illustrations, briefly describing the failure of a low mill dam, due to lack of maintenance. 500 w. *Eng Rec*—April 27, 1912. No. 32396.

Dams

Provision for Uplift and Ice Pressure in Designing Masonry Dams. Continued discussion of the paper by C. L. Harrison. 2500 w. *Pro Am Soc of Civ Engrs*—March, 1912. No. 32133 F.

Provision for Uplift and Ice Pressure in Designing Masonry Dams. Continued discussion of paper by C. L. Harrison. 3300 w. *Pro Am Soc of Civ Engrs*—April, 1912. No. 32382 F.

High Dams of Great Length. Reginald Ryves. From a paper read before the Concrete Inst. A study of the mass gravity type and three types of span dams. Ills. Also discussion. 4000 w. *Surveyor*—March 22, 1912. No. 31722 A.

Diversion Works for the Arrowrock Dam. Charles H. Paul. Illustrated account of the tunnel works for diverting the waters of the Boise river from the site of the world's highest dam. 2000 w. *Eng Rec*—April 6, 1912. No. 31816.

The New Kensico Dam. Alfred D. Flinn. Illustrated description of this mammoth masonry dam, about 15 miles north of New York City. Gives specifications. 6000 w. *Eng News*—April 25, 1912. No. 32367.

Construction of the Morena Rock Fill Dam, San Diego County, California. Continued discussion of M. M. O'Shaunessy's paper. Ills. 1500 w. *Pro Am Soc of Civ Engrs*—March, 1912. No. 32132 F.

Filtration

Some Notes on Tropical Water Supply and Study of Filtration at Panama. Herman K. Higgins. A discussion by E. W. Clarke of Mr. Higgins' paper. 2200 w. *Jour N-Eng W-Wks Assn*—March, 1912. No. 32352 F.

Minneapolis Mechanical Water Filtration Scheme. A. W. Ellson Fawkes. Illustrated detailed description. 4000 w. *Can Engr*—April 11, 1912. No. 31958.

The New Filter Gallery at Des Moines. Illustrated description of method of extending the supply by means of reinforced concrete pipe collectors which are separated by quarter-inch lugs. 1500 w. *Eng Rec*—April 27, 1912. No. 32392.

Albany Water Filtration. Review of last year's methods and results. Ills. 3000 w. *Munic Jour & Engr*—April 11, 1912. No. 31933.

Flow

The Flow of Water Through a Porous Medium. L. R. Balch. Considers the conditions which influence the rate of flow as shown by previous experiments. 1500 w. *Wis Engr*—April, 1912. No. 32412 C.

Flumes

Timber Expansion in Flumes; Causes and Remedies. Godfrey Sperling. From *Trans. of Am. Met. Soc.* Describes flumes in Idaho, constructed in 1910, for placer-mining purposes, their partial failure, and reconstruction. 1600 w. *Can Engr*—April 25, 1912. No. 32443.

Flume Construction in Colombia. R. D. O. Johnson. An illustrated account of methods used in constructing two flumes. 2200 w. *Eng & Min Jour*—March 30, 1912. No. 31678.

Intakes

Construction of Intakes and Discharge Works, Northwest Power Station, Chicago. Brief illustrated description of the double-bore reinforced concrete water tunnel built behind a river dock for intake and drainage. 1200 w. *Eng Rec*—April 6, 1912. No. 31819.

Irrigation

Irrigation Projects. F. C. Lyman. Brief notes on reclamation projects being carried out in the western part of the United

States. Ills. 1000 w. Yale Sci M—April, 1912. No. 32151 C.

The Irrigation System of the Southern Alberta Land Co., Ltd. Augustine H. Ayers. Map and illustrated account of the work. 2500 w. Engng & Con—April 10, 1912. No. 31913.

Irrigation in the Spokane Valley. L. J. Corbett. Remarks on the changes due to irrigation, with description of methods used and information concerning costs. Ills. 3500 w. Pro Am Inst of Elec Engrs—April 16, 1912. No. 32425 F.

Irrigation on the Royal Murgab Estate, Turkestan, Russia. Arthur P. Davis. Illustrated description of this property and the different irrigation projects built. 1500 w. Eng News—April 4, 1912. No. 31797.

See also Tunnels, under *Construction*.

London

The Research Work of the Metropolitan Water Board. From Dr. Houston's latest report, dealing with experiments to determine whether disease germs are present in the water, and the pre-treatment needed to destroy them before entering the storage reservoir. 2500 w. Surveyor—April 5, 1912. No. 31988 A.

Meters

Some Things Domestic Meters Do Not Accomplish. William S. Johnson. Also discussion. Need of studying conditions and the water unaccounted for. 5000 w. Jour N Eng W-Wks Assn—March, 1912. No. 32354 F.

Pipe Corrosion

The Relative Corrosion of Iron and Steel Pipe as Found in Service. (Abstract.) William H. Walker. Also discussion. Results seem to show that there is no difference. 1300 w. Jour N Eng W-Wks Assn—March, 1912. No. 32353 F.

Pipe Testing

Leakage Tests of 36-Inch Cast Iron Pipe at Columbus, Ohio. John H. Gregory. Describes the pipes, gives the specification requirements, and report of tests. 1200 w. Eng Rec—April 20, 1912. No. 32193.

Purification

Reinforced Concrete for Hypochlorite Solution Tanks. Dr. Walter M. Cross. From a paper read before the Nat. Assn. of Cement Users. Describes the plant at Kansas City, Mo. 1200 w. Can Engr—April 18, 1912. No. 32228.

The "Tiltometer" Chemical Injector. Illustrated description of an apparatus designed primarily for the treatment of large quantities of water, sewage, or trade wastes. 2000 w. Engr, Lond—March 29, 1912. No. 31897 A.

Reservoirs

The Advantages and Limitations of Circular Reinforced Concrete Reservoirs—Enlargement of Such a Reservoir at Suffern, New York. 1500 w. Eng & Con—April 10, 1912. No. 31912.

A Combined Fire-Service Reservoir and Swimming Pool in California. Illustrates and describes a 550,000-gallon concrete reservoir with a special watertight joint between the side walls and the floor. 2000 w. Eng Rec—April 6, 1912. No. 31818.

Sprinkling

A Simple Automatic System for Lawn Sprinkling, Los Angeles, Calif. Burt A. Heiny. Illustrated description of the spray irrigation system used in the parks. 1200 w. Eng News—April 11, 1912. No. 31939.

Test Methods

A New Water-Testing Device. Illustrated description of an apparatus known as the Dionic water-tester, used as an indicator of any variations in the organic contents. 1800 w. Can Engr—April 18, 1912. No. 32230.

Water Power

Water Power Development under Government Control. O. C. Merrill. From a paper read before the San Francisco Assn. of the members of the Am. Soc. of Civ. Engrs. Outlines the policies followed by Italy, Switzerland, Ontario, New York State, and the U. S. Dept. of Agriculture. 3000 w. Eng Rec—April 27, 1912. No. 32395.

See also same heading under ELECTRICAL ENGINEERING, *Generating Stations*.

Water Rights

The Appraisal of Water Rights. Discusses the determination of the value of the water rights as given in a report by Halbert P. Gillette to the Everett (Wash.) Ry., Light & Water Co. 6000 w. Engng & Con—April 17, 1912. No. 32143.

Notes and Suggestions on the New Water Rights Laws (Betrachtungen und Vorschläge zur Wasserrechtsgesetz-novelle). J. Tobell. Discussion on some of the Articles of the recently enacted Prussian water legislation. 3600 w. Elektrotech u Maschinenbau—Mar. 24, 1912. No. 32070 D.

Water Wastes

Results of the Water Waste Survey in Milwaukee, Wis.—Conclusions and Recommendations—Increased Meterage Desirable. From Bul. No. 11, issued by the Bureau of Economy and Efficiency, summarizing recent investigations. 2500 w. Engng & Con—April 24, 1912. No. 32326.

Water Works

Some Features and Methods of Water Works Operation in Springfield, Illinois. W. J. Spaulding. Abstract of a paper before the Ill. Water Sup. Assn. Considers meters, free water, extension of mains, and service connections. 2500 w. Engng & Con—April 3, 1912. No. 31791.

An Inexpensive Water Works. Edward P. Bailey. Brief illustrated description of the system at Brawley, in the Imperial Valley, California, with itemized cost. 1200 w. Munic Jour & Engr—April 18, 1912. No. 32166.

Erie Water Works Improvements. Thomas Fleming, Jr. Describes the present plant and the proposed additions. 2500 w. *Munic Jour & Engr*—April 4, 1912. No. 31796.

Water-Works Practice

The Drafting Room Practice of the Board of Water Supply, New York City. Explains methods of making, filing, and reproducing contract drawings. 3000 w. *Eng Rec*—April 6, 1912. No. 31820.

Weirs

Flow of Water Over Narrow Weirs. Abstract from thesis by H. W. Maynard and J. P. Hurley. Report of experimental investigations of the limitations of the Francis' formula. Ills. 2000 w. *Cornell Civ Engr*—April, 1912. No. 32188 C.

Water Supply for the West Australian Gold Fields. L. E. Shapcott. Brief illustrated description of the Mundaring weir, which supplies water to the Kalgoorlie goldfields. 500 w. *Sci Am Sup*—April 27, 1912. No. 32335.

WATERWAYS AND HARBORS

Canals

Feeding System of the Orleans Canal by the Elevation of Water Through Successive Water Courses (*Alimentation du Canal d'Orleans par Élévation de l'Eau de Bief en Bief*). M. Rousseau. Describes method of supplying water to the canal across the watershed between the Loire and Seine. Plates. 5000 w. *Ann d Ponts et Chaussées*—Jan.-Feb., 1912. No. 32076 E + F.

Docks

A Modern Iron Ore Dock and Unloading Plant. Illustrated description of details of the dock at Cleveland, and of the Hulett unloaders and ore bridge. 3000 w. *Ir Trd Rev*—April 18, 1912. No. 32201.

The New Iron Ore Dock at Port Bolivar. William B. Phillips. Illustrated description of loading facilities on Galveston Bay for the ores of east Texas. 1200 w. *Ir Age*—April 18, 1912. No. 32142 C.

Drainage

Reclaiming Land by Drainage. Hugh R. McVeigh. Illustrated account of projects in lower Mississippi valley embracing 2,300,000 acres. 4000 w. *Mfrs' Rec*—April 18, 1912. No. 32165.

Ditch System for Draining 103,000 Acres in Washington County, Mississippi. Outlines the natural drainage, and explains the plan, giving cost estimates. 5000 w. *Engng & Con*—April 3, 1912. No. 31792.

Dredging

Current Practice in Blasting and Dredging Rock Under Water. Conclusions from a review by W. L. Saunders reported to the Int. Cong. of Nav. 6500 w. *Engng & Con*—April 24, 1912. No. 32323.

Floods

Forests and Floods on the North Pacific Coast. H. M. Chittenden. Data relating to floods in certain streams of western

Washington in Nov., 1911. 2000 w. *Eng News*—April 11, 1912. No. 31936.

The 1912 Floods in the Ohio and Mississippi Rivers. H. C. Frankenfield. Gives the history of conditions preceding this great flood and describes its progress down the river. 2000 w. *Eng News*—April 18, 1912. No. 32214.

See also River Regulation, under *Waterways and Harbors*.

Inland Navigation

The Scientific and Economic Advantages in the Construction of an Inland Waterway through Tuscany and Umbria to Rome (*Sulla convenienza tecnica ed economica di aprire una via di navigazione per la Toscana e per l'Umbria alla città di Roma*). Report of a committee upon the feasibility and desirability of such a project. Maps. 11000 w. *Ann della Soc d Ing e d Arch Ital*—Feb. 16, 1912. No. 32303 E.

Panama Canal

Panama—Personal Impressions of the Work on the Canal. J. Bernard Walker. First of a series of articles based on a recent visit to the work. Ills. 2000 w. *Sci Am*—April 20, 1912. Serial. 1st part. No. 32173.

Backwater Wave in the Spillway Channel, Gatun, Panama Canal. Edward C. Sherman. Explains conditions, the dangers and investigations to avert damage. Ills. 1000 w. *Eng News*—April 25, 1912. No. 32374.

Piers

Reinforced Concrete Substructure of the Havana Docks Company's Piers. Illustrates and describes work interesting on account of the design of piers and the fabrication and driving of piles. 2000 w. *Eng Rec*—April 27, 1912. No. 32393.

River Improvement

Improving Upper Mississippi River. E. F. Linderman. Describes the character of the works and the methods of executing them. Ills. 3000 w. *Eng News*—April 11, 1912. No. 31935.

See also Barges, under MARINE AND NAVAL ENGINEERING.

River Regulation

The Proposed Reservoir System of the Allegheny and Monongahela Rivers. Extracts from a forthcoming report of the Nat. Waterways Commission. Also "The Flood of March 22, at Pittsburg, Penn." Kenneth C. Grant. Description. 3500 w. *Eng News*—April 4, 1912. No. 31801.

Shore Protection

Shore Protection Along the Po (*Sulle difese frontali lungo Po*). Review of paper by Prof. Bonati on various proposals for dikes, etc., on the Po in time of flood. Ills. 2400 w. *Monit Tecnico*—Mar. 10, 1912. No. 32306 D.

Stream Pollution

West Riding Rivers and Trade Effluents. A review of the seventh report of

the Royal Commission on Sewage Disposal on "Trade Effluents." 2500 w. Engng—April 12, 1912. Serial. 1st part. No. 32278 A.

Water-Fronts

The Problem of the Lower West Side Manhattan Water-Front of the Port of New York. Discussion of the paper by B. F. Cresson, Jr. 7800 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32135 F.

The Problem of the Lower West Side Manhattan Water-Front of the Port of New York. Continued discussion of the paper by B. F. Cresson, Jr. 13000 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32385 F.

ELECTRICAL ENGINEERING

COMMUNICATION

Exchanges

Automatic Private Branch Exchange Development in San Francisco. Gerald Deakin. Describes briefly the apartment house and the commercial automatic private branch exchange systems as developed in San Francisco, their advantages, disadvantages and cost. 9800 w. Pro Am Inst of Elec Engrs—April, 1912. No. 32428 F.

Radiotelegraphy

The Present Position of Wireless Telegraphy. Count George von Arco. From a paper reprinted in the *All. Elek. Gesell. Jour.* Reviews the progress of the last few years. 2500 w. Eng News—April 25, 1912. No. 32372.

Electrostatic Effects in Receiving Transformers for Radiotelegraphy. G. W. O. Howe. Shows that the sensitiveness depends on the mode of earthing the transformer relatively to the aerial. 500 w. Elect'n, Lond—March 29, 1912. No. 31881 A.

Wireless Telegraphy in Horology, Navigation and Cartography. S. M. Powell. Notes from articles in *La Lumière Elec.* and the Supplement to *La Tech. Mod.* Its use in the transmission of time signals and the determination of differences of longitude. 3000 w. Elec Rev, Lond—April 5, 1912. No. 31908 A.

Marconi Lecture Before New York Electrical Society. Reviews the chief features discussed by the speaker on April 17. 3000 w. Elec Wld—April 27, 1912. No. 32454.

Wireless Telegraphy at Cornell University. L. F. Fuller. Brief historical sketch of the station and a synopsis of an investigation of the "Receiving Characteristics of the Umbrella Type Aerial." Ills. 1800 w. Sib Jour of Engng—March, 1912. No. 32124 C.

Some Experiments in "Wired-Wireless" Telegraphy for Field Lines of Information for Military Purposes. George O. Squier.

Waterways

The National Waterways Commission. Gives a summary of the conclusions and recommendations contained in the Commission's final report. 5000 w. Eng News—April 25, 1912. No. 32373.

MISCELLANY

Agricultural Implements

Ancient European Plows (Les Anciennes Charrues d'Europe). H. Chevalier. A historical sketch of the plows and plowing methods employed in early European agriculture, as illustrated by old cuts. 11500 w. Mem Soc Ing Civ de France—Jan., 1912. No. 32080 G.

Describes preliminary experiments involving a combination of these two methods for field service. Ills. 2000 w. Jr Fr Inst—April, 1912. No. 32162 D.

Girdling the Globe by Wireless. Dudley Harmon. An illustrated account of the plan of the U. S. Navy Department to construct a chain of wireless stations connecting two oceans and a continent. 1200 w. Sci Am—April 20, 1912. No. 32172.

See also "Titanic" Disaster, under MARINE AND NAVAL ENGINEERING.

Telegraphy

Will the Signal be Lengthened on Alternating-Current Telegraphy? Béla Gáti. Abbreviated translation from *Elektrotechnik und Maschinenbau*. Shows that lengthening is a peculiarity of direct current and does not occur in alternating current signals. 1200 w. Elect'n, Lond—April 12, 1912. No. 32254 A.

Trans-Atlantic Telegraphy. Charles Bright. Observations on the speech made in opposition to the Imperial Atlantic Cable at a recent meeting. 800 w. Elec Rev, Lond—April 5, 1912. No. 31907 A.

DISTRIBUTION

Conduits

Installing Conduit Services. George L. Forrest. Illustrates and describes work. 500 w. Elec Rev & W Elect'n—April 13, 1912. No. 31967.

See also Underground Systems, under *Distribution*.

Switches

A Flame-Tight Switch and Fuse Box. Illustrated description of a special gate-end switch and fuse box suitable for rough conditions. 1000 w. Ir & Coal Trds Rev—April 5, 1912. No. 32107 A.

Underground Systems

Conduit Considerations for Underground Distribution Systems. William D. Ligon. Illustrated review of developments in underground distribution and engineering features of tile and fibre conduit systems. 1500 w. So Elect'n—April, 1912. No. 31812.

Alternating-Current Systems of Underground Distribution. S. J. Lisberger and C. J. Wilson. Briefly compares direct and alternating current systems and describes the latter. 3000 w. Pro Am Inst of Elec Engrs—April, 1912. No. 32427 F.

An Underground System and a Few Developments. S. B. Clark. Describes the underground system at Portland, Ore., discussing features of underground work. 2200 w. Pro Am Inst of Elec Engrs—April, 1912. No. 32426 F.

Wiring

Concerning Safe Wiring. Waldemar Michaelsen. Read before the Neb. Elec. Assn. Suggestions. 1800 w. Elec Rev & W Elect'n—April 27, 1912. No. 32402.

Engineering Considerations in Installing Residence Electrical Equipment. Gives practical data and suggestions for architects, electrical contractors, and central station engineers. 4000 w. So Elect'n—April, 1912. No. 31813.

Inspection of Electric Wiring in Sparsely Settled Districts. W. J. Canada. The importance of good installations is shown and rules are given to supplement the National Electrical Code. 2000 w. Elec Wld—April 20, 1912. No. 32226.

Proposed Legislation by the State Commission Concerning Electric Wiring (Mededeelingen betreffende het Ontwerp Electriciteitswet der Staatscommissie voor de Electricische Geleidingen). L. M. Barnett Lyon. Paper read before the Electro-technic Society and general discussion. 9000 w. De Ingenieur—March 23, 1912. No. 32073 D.

DYNAMOS AND MOTORS

Commutators

Flashing-Over in Commutator Machines. Abstract of a paper by W. W. Firth read before the Newcastle Sec. of the Inst. of Elec. Engrs. and of the discussion. Explain causes. 2000 w. Ir & Coal Trds Rev—April 5, 1912. No. 32108 A.

Single-Phase Commutator Motors. R. E. Hellmund and E. W. P. Smith. Discusses design details in connection with motors of this type, especially motors with "preventive" leads in the armature winding. 2500 w. Elec Jour—April, 1912. No. 32183.

Progress in the Commutation of Single-Phase Commutator Motors (Fortschritte in der Commutierung von Einphasencommutatormotoren). W. Wolf. Presents recent practice. Ills. Serial. 1st part. 2000 w. Elek Rundschau—April 11, 1912. No. 32319 D.

D. C. Generators

The Three-Wire Direct-Current Generator. William V. Merowitz. Describes a self-contained machine for operating three-wire systems. 1200 w. Elec Wld—April 13, 1912. No. 31964.

Induction Motors

Accelerating Characteristics of an Induction Motor. E. R. Shepard. Discusses

methods employed in an attempt to determine the relation between speed and time while accelerating, and other matters of interest. 1200 w. Elec Wld—April 27, 1912. No. 32456.

The Hysteresis Torque of Induction Machines. Dr. Hans Riddervold. Explanation of its effect and measurement. 1000 w. Elec Wld—March 30, 1912. No. 31706.

Prime Movers

Weight Efficiency of Electric Motors and of Prime Movers. W. B. Hird. Read before the Inst. of Elec. Engrs. Considers the relation of weight to output. 3000 w. Mech Engr—April 12, 1912. No. 32268 A.

The Size and Cost of Electric Generators in Relation to the Type of Prime Mover. Humphrey Maccallum. Discusses the output and speed of the units and the relation between the size and output of electric generators, and the effect on the cost. 1500 w. Mech Engr—April 12, 1912. No. 32266 A.

Railway Motors

Methods Used in Mounting Railway Motors. Considers methods used in mounting the motor on the truck. Ills. 1500 w. Ry & Loc Engng—April, 1912. No. 31750 C.

Starters

Self-Starting Synchronous Motors. Carl J. Fechheimer. Gives calculations and formulae, explaining the principle upon which they are based, and an analytical treatment of the subject applied to motors with definite pole construction. 12600 w. Pro Am Inst of Elec Engrs—April, 1912. No. 32423 F.

Turbo-Alternators

The Mechanical Effect from Unexpected Short-Circuits in Turbo-Alternators (Les Effets Mécaniques des Court-Circuits Brusques sur les Turbo-Alternateurs). M. P. Boucherot. Mathematical discussion. Diagrams. 4900 w. Mem Soc Ing Civ de France—Jan., 1912. No. 32081 G.

ELECTRO-CHEMISTRY

Electrolysis

Electrolytic Dissociation. Svante Arrhenius. From the *Jour. of the Am. Chem. Soc.* Gives an outline of the history of the ionic theory as sketched by its founder. 4500 w. Sci Am Sup—April 20, 1912. No. 32174.

Electroplating

The Operation of Duplex Copper Baths. Seymour W. Rowsbar. Suggestions for electroplating. 1500 w. Foundry—April, 1912. No. 31694.

ELECTRO-PHYSICS

Coils

The Calculation of High Tension Reactance Coils Free of Iron (Die Berechnung eisenfreier Drosselspulen für Starkstrom). Fritz Emde. Mathematical discussion. Diagrams. Serial. 1st part. 2400 w. Elektrotech u Maschinenbau—March 17, 1912. No. 32069 D.

The Inherent Temperature in Round Coils (Die Beharrungstemperatur im Innern von runden spulen). Karl Gruber. Mathematical discussion. Serial. 1st part. 1200 w. Elek Rundschau—April 11, 1912. No. 32320 D.

Conductors

Network of Electrical Conductors. Francis B. Crocker. Discusses principles and methods for designing and calculating network distribution systems. 2000 w. Elec Wld—April 13, 1912. Serial. 1st part. No. 31963.

Dielectrics

On the Power Factor and Conductivity of Dielectrics When Tested with Alternating Electric Currents of Telephonic Frequency at Various Temperatures. J. A. Fleming and G. B. Dyke. A study. 18000 w. Inst of Elec Engrs—March, 1912. No. 31878 N.

Heat Transmission

See Electrical Machinery, under *Power Applications*.

Magnetism

The Magnetization of Cobalt as a Function of the Temperature, and the Determination of Its Intrinsic Magnetic Field. W. W. Stifler. Abstract from *Phys. Rev.* Reports an investigation to determine the specific intensity of magnetization at various temperatures. 800 w. Elect'n, Lond—March 29, 1912. No. 31880 A.

Tests for the Absolute Determination of the Magnetization of Dynamo Sheets in Epstein Coils (Verfahren zur absoluten Bestimmung der Magnetisierung von Dynamoblech an Epstein-Bündeln). E. Gumlich and W. Rogowski. Presenting a curve theory for this determination. Serial. 1st part. 2800 w. Stahl u Eisen—March 14, 1912. No. 32007 D.

Radioactivity

The Gif Laboratory for Radio-Active Examinations. M. Jacques Danne, in *Le Génie Civil*. Describes a novel institution, near Paris, designed especially for technical work. 2000 w. Sci Am Sup—April 20, 1912. No. 32176.

Relativity

The Principle and Mechanics of Relativity (Le Principe de Relativité et la Mécanique). E. M. Lémeray. Studies on the Lorentz theory of electrons. 8500 w. Rev Gen des Sciences—March 15, 1912. No. 32090 D.

Resistance

Electric Resistance of Special Steels (Résistance Électrique des Aciers Spéciaux). O. Boudouard. Studies on the resistance of carbon, nickel, manganese, chrome and tungsten steels after the methods of Kelvin and Carpentier. 3000 w. Rev de Metall—April, 1912. No. 32089 H.

The Resistance of Iron in Alternating Currents (Sur la Résistance du Fer en Courant Alternatif). M. E. Brylinski. Mathematical discussion on the resistance

and self-induction of iron. Diagrams. 13600 w. Bull Soc Int d'Electriciens—March, 1912. No. 32083 F.

Vector Diagrams

The Vector Diagram of the Single-Phase Repulsion Motor. Thomas F. Wall. Develops the vector diagram and compares the results with those obtained by the analytical method, showing the latter to be more accurate. 3000 w. Elect'n, Lond—April 12, 1912. No. 32256 A.

GENERATING STATIONS

Accumulators

Volume Changes in Accumulator Electrodes. C. Toone. Gives studies of working changes in the volume of accumulator plates. 900 w. Elec Rev, Lond—March 22, 1912. No. 31720 A.

Batteries

Dry Batteries: The Relation Between the Incidence of the Discharge and the Relative Capacity of Cells of Different Manufacture. S. W. Melsom. Gives results of investigation of four different cells. Short discussion. 1500 w. Elect'n, Lond—April 12, 1912. No. 32253 A.

Central Stations

Lake Shore Station of Cleveland Electric Illuminating Company. Illustrated description of a station illustrating good modern practice. 1800 w. Elec Wld—March 30, 1912. No. 31704.

Economy

Economy Factors in Power Plants. Charles Brossmann. From a paper before the Indiana Engng. Soc. Considers small things which seriously affect the economy. 1200 w. Power—April 16, 1912. No. 31975.

Earnings

Central Station Motor-Service Earnings. Gives unit analysis of sales of electricity for motor applications in six Massachusetts companies. 600 w. Elec Wld—April 13, 1912. No. 31965.

Efficiency

Induction Motor Drive Plant Efficiency. H. W. Young. Explains the use of the graphic recording watt-meter for raising the power factor and increasing the efficiency. 1500 w. Ind Engng—April, 1912. No. 31978 C.

Hydro-Electric

The Hydro-Electric Developments of the North Carolina Electrical Company. N. Buckner. Brief description of Ivy and Weaver plants with illustrated details of Marshall station. 1500 w. So Elect'n—April, 1912. No. 31811.

The White River Development of the Pacific Coast Power Company. Illustrated description of a 36,000 h.p. plant operating under a head of 440 ft. and having sufficient storage to supply full power for a month. 3500 w. Eng Rec—April 13, 1912. No. 31950.

The White River Power Development in Washington. Illustrated detailed description of a development adding 36,000 h.p.

and an enormous storage capacity. 3000 w. Eng News—April 11, 1912. No. 31941.

Large Swedish Hydro-Electric Plant. J. B. Van Brussel. Brief illustrated description of the 100,000 h. p. plant at Trollhättan. 1000 w. Power—April 23, 1912. No. 32244.

The Water Power Development of the Mississippi River Power Company, at Keokuk, Iowa. Hugh L. Cooper. Abstract of an illustrated address describing the largest hydro-electric plant in the world. 4000 w. Jour W Soc of Engrs—March, 1912. No. 32126 D.

Water Power from the Beauharnois Canal. Illustrated description of a development to supply light and power to Montreal, Que. 2000 w. Eng Rec—April 6, 1912. No. 31822.

The Albula Plant (Das Albulawerk). Abstracts from *Elektrizitätswerkes der Stadt Zürich* by H. Peter and H. Wagner. Description of plant on the Albula River which supplies power to Zürich about 85 miles distant. Ills. 3500 w. Elek Kraft u Bahnen—March 14, 1912. No. 32065 D.

The Gail Plant (Die Gailwerke). L. Bernhard. Description of power plant on the Gail River, Villach, Austria; the diversion dam, power house, etc. Ills. Serial. 1st part. 3200 w. Elektrotech u Maschinenbau—March 10, 1912. No. 32068 D.

See also Water Power, under *Generating Stations*.

Isolated Plants

A German Rural Power Plant. Dr. Alfred Gradenwitz. Illustrated description of plant to generate power for agricultural uses. 1200 w. Power—April 16, 1912. No. 31976.

Lighting Plants

The Lister-Bruston Automatic Electric Lighting Plant. Illustrated description of details of a plant suitable for the electric lighting of country houses and other premises. 1000 w. Engng—March 22, 1912. No. 31731 A.

Minneapolis

Minneapolis General Electric Company's New Power System. Illustrated description of the general plan and construction details of a new system replacing the station destroyed by fire. 2500 w. Elec Wld—April 27, 1912. Serial. 1st part. No. 32455.

Power Costs

Cost of Isolated Plant Power. From a paper prepared by the Am. Engine Co. Outlines a method of arriving at the cost. 1500 w. Power—April 2, 1912. No. 31709.

Power Plants

Small Chinese Power Plant. Walter H. Adams. Illustrated description of a plant supplying light, heat and power to the buildings of the Imperial Pei-Wang University. 2000 w. Power—April 30, 1912. No. 32434.

Rates

Rates for Electricity. R. L. Ellis. Discusses the proper basis for correct service schedules. 4000 w. Engineering Magazine—May, 1912. No. 32346 B.

Electric Rates. Herman H. Spohrer. Gives schedule adopted in St. Louis. 1500 w. Elec Rev & W Elect'n—April 20, 1912. No. 32236.

A Method of Investigating an Existing Rate Schedule for Motor Service. F. B. Fletcher. Discusses methods of collecting and compiling a general review of the motor-service. 1600 w. Elec Wld—March 30, 1912. No. 31707.

Switchboards

Some Notes on Control Boards for Large Electrical Power Stations. S. W. Mauger. Illustrates and describes designs. 1500 w. Elec Rev & W Elect'n—April 13, 1912. No. 31968.

Turbine Drive

Turbine-Driven Station at Atlantic City, N. J. Illustrated description of a new plant for the supply of electricity and hot-water heat. 1800 w. Elec Wld—April 6, 1912. No. 31849.

Water Power

Selection of a Water Wheel Unit. O. B. Coldwell. Discusses the features entering into the design which will best meet stated conditions, and the information that should be given the designer. 5500 w. Pro Am Inst of Elec Engrs—April 16, 1912. No. 32424 F.

LIGHTING

Bulbs

Vacuum Testing of Glass Bulbs (Vacuumprüfung von Glühbirnen). Bruno Thieme. Describes method of testing by use of the Tesla apparatus. Ills. 1000 w. Elektrotech Rundschau—March 27, 1912. No. 32063 D.

Illumination

Daylight. Edward L. Nichols. A study. 4000 w. Jour Fr Inst—April, 1912. No. 32161 D.

Illumination: Production, Calculation, Measurement. J. D. Mackenzie. Read before the Scottish Sec. of the Inst. of Elec. Engrs. (Abstract.) Discusses the calculation of illumination in given cases, and the measurement. 3500 w. Elect'n, Lond—April 12, 1912. No. 32255 A.

On the Ultra-Violet Energy in Artificial Light Sources. Louis Bell. Describes a study of the effect on human eyesight. Ills. 4000 w. Elec Wld—April 13, 1912. No. 31966.

Underground Lighting with Low Voltage Metallic-Filament Lamps. F. Milburn. Read before the N. of Eng. Branch of the Assn. of Min. Elec. Engrs. Discusses mine lighting, its safety, cost, and efficiency. 1400 w. Ir & Coal Trds Rev—April 5, 1912. No. 32109 A.

Ornamental Luminous Arc Lighting at New Haven. C. A. B. Halvorsen. Explains reasons for selecting the system,

and describes method of installation and the results. Ills. 1500 w. Gen Elec Rev—April, 1912. No. 31864 C.

Incandescent Lamps

Modern Incandescent Electric Lamps. Leonard J. Lewinson. Discusses lamps employing filaments operating in high vacuum, comparing lamps in present commercial use. Ills. 6500 w. Sch of Mines Qr—April, 1912. No. 32159 D.

Lamp Standards

Artistic Street Lamp Standards. Illustrates novel designs, considering their merits. 2000 w. Elec Rev, Lond—March 22, 1912. No. 31719 A.

Metallic Filaments

Condensers for Metallic Filament Lamps. Explains the theory of employing condensers for reducing the voltage at the terminals of electric lamps. 2000 w. Engr, Lond—March 22, 1912. No. 31732 A.

Rates

Adjustment of Electric Lighting Rate. Extracts from the reports of the Wisconsin Ry Commission, and a paper by Prof. Cory, showing the influence of the load factor upon the total cost. 2500 w. Power—April 7, 1912. No. 31852.

Street Lighting

Street Lighting in Series by Metallic Arcs and Mercury Rectifiers (La illuminazione stradale con serie di archi metallici e apparecchi rettificatori a mercurio). Guido Peri. Details of such systems. Ills. Serial. 1st part. 3300 w. Industria—April 7, 1912. No. 32312 D.

Train Lighting

See same heading, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

MEASUREMENT

Rheostats

Carbon-Plate Rheostats. Charles R. Moore. A report of experiments to supply data for the design of such apparatus. Ills. 1200 w. Elec Rev & W Elect'n—April 6, 1912. No. 31839.

Standardization

Standardization. H. F. Chadwick. Explains cases where a general standardization is possible and outlines the work of the Bureau of Standards and of various societies. 2500 w. Elec Jour—April, 1912. No. 32179.

Electrochemical and Electrothermal Calculations. Carl Hering. Abstract from paper read before the Am. Elec.-Chem. Soc. Gives recommendations by the writer for standardization of terms, units, nomenclature, etc. 1500 w. Min & Engng Wld—April 13, 1912. No. 31973.

POWER APPLICATIONS

Agriculture

Electric Power Applications on the Farm. Frank Koester. The present article discusses electric plowing, and electrically operated refrigerating plants. Ills. 2500 w. Elec Rev & W Elect'n—April 20, 1912. No. 32235.

See also Motor Plows, under *Power Applications*; and Isolated Plants, under *Generating Stations*.

Breweries

Electricity in Breweries. An analysis of the operating conditions, with information on the selection of motors, h.p. requirements, and power data on six installations. Ills. 4000 w. Elec Rev & W Elect'n—April 27, 1912. No. 32400.

Coast Defense

The Utilization of Electricity in United States Coast Defense. L. B. Bender. Illustrates and describes important applications. 3000 w. Elec Wld—March 30, 1912. No. 31705.

Electrical Machinery

Thermal Conductivity and Resistivity. Reviews results obtained by different experimenters. 1800 w. Wis Engr—April, 1912. No. 32411 C.

High-Speed Electrical Machinery. F. H. Clough. Read before the Rugby Engng Soc. Considers the difficulties in developing high-speed generators and the problems in connection with the design. 5000 w. Mech Engr—April 5, 1912. No. 31991 A.

Motor Plows

Motor Plowing from an Industrial Standpoint (Das Motorpflugwesen vom Standpunkte der Industrie). Dr. Martiny. Extensive illustrated review of the commercial possibilities of the motor plow. Serial. 1st part. 10,000 w. Motorwagen—March 20, 1912. No. 32060 D.

Phonograph

A New Phonograph. Illustrated description of the method developed by S. Lifschitz, a new optical phonograph. 1000 w. Sci Am—April 27, 1912. No. 32333.

TRANSMISSION

Cables

The Inter-Relation of Capacity in Three-Phase Three-Core Cables. A. B. Clark. Shows how from two capacity measurements all the other combinations can be calculated. 800 w. Elec Rev, Lond—April 5, 1912. No. 31905 A.

High-Voltage

Highest-Voltage Transmission System in the World. Illustrated description of the plant of the Au Sable Elec. Co., supplying electricity to Bay City, Saginaw, and Flint, Mich. 2500 w. Elec Wld—April 13, 1912. No. 31962.

Insulators

High-Tension Porcelain Line Insulators. J. Lustgarten. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses the properties of electrical porcelain, the various forms of pin and suspension insulators, their design and operating features. 2500 w. Elect'n, Lond—March 29, 1912. No. 31879 A.

Line Protection

Protection of High Tension Power Circuits and Apparatus. James Lyman. Deals with the protection of heavy a. c. power feeders and power house apparatus.

Ills. Also discussion. 11000 w. Jour W Soc of Engrs—March, 1912. No. 32128 D.

Poles

Preservation of Power Transmission Poles. W. R. Wheaton. An account of methods in California and results. 2000 w. Eng News—April 4, 1912. No. 31798.

Transformers

Starting Currents of Transformers with Special Reference to Transformers with Silicon Steel Cores. Trygve D. Yensen. Facts relating to the rush of current, due to the residual magnetism of the transformer iron, showing how to protect the system from injury due to this cause. Ills. 43 pages. Bul Univ of Ill, No. 55—Feb. 19, 1912. No. 32154 C.

A Bell-ringing Transformer. Frederick E. Ward. Brief illustrated description of a transformer that will ring door-bells and may be applied to various uses. 700 w. Sci Am—April 27, 1912. No. 32334.

Outdoor Type Transformers. C. S.

Lawson. Illustrated descriptions of types and their installation. 1800 w. Elec Jour—April, 1912. No. 32181.

The Calculation of Three-Phase Power Transformers with Unsymmetric Wiring (Ueber die Berechnung von langen Drehstrom-kraftübertragungen mit unsymmetrisch angeordneten Leitungen). G. Markovitch. Mathematical discussion. 4400 w. Elektrotech u Maschinenbau—March 31, 1912. No. 32071 D.

Wires

Wires for Direct-Current Circuits. Cecil P. Poole. Tables for determining the proper size of wire, with explanation. 3500 w. Power—April 2, 1912. No. 31711.

MISCELLANY

Tests

Fraudulent Tests. An exposure of some of the forms of fraud in obtaining official certificates. 2500 w. Elec Rev, Lond—April 5, 1912. Serial. 1st part. No. 31906 A.

INDUSTRIAL ECONOMY

Accounting

Bookkeeping for Contract Work. Louis Levy. Read before the Elec. Cont. Assn. of San Francisco. Outlines the system and methods used. 1500 w. Elec Rev & W Elect'n—April 27, 1912. No. 32401.

Accounting System for the Small Electrical Contractor. Roy W. Eves. Explains system. 2000 w. Elec Rev & W Elect'n—April 20, 1912. No. 32237.

Applied Science

Manager and Scientist. H. F. Stimpson. Discusses the relation of applied science to business. 3500 w. Cassier's Mag—April, 1912. No. 31833 B.

Appraisals

The Appraisal of Public Service Properties as a Basis for the Regulation of Rates. C. E. Grunsky. An analysis of the problem, explaining the principles which should prevail when an appraisal is made for rate-regulation purposes. 22000 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32381 F.

Apprenticeship

Features of Apprenticeship System at the G. E. Co.'s Lynn Works. Chester L. Lucas. Illustrated description of the new quarters, with an outline of some of the work. 3000 w. Mach, N Y—April, 1912. No. 31674 C.

Associations

Employers Alliances (Arbeitgeberverbände). Paul Steller. Outlines the causes for the formation of such protective alliances, and states some of their effects. 4800 w. Zeit f Werkzeug—March 25, 1912. No. 32058 D.

Commerce

The Opportunities of the United States in South American Commerce. Francis

Washburn Hoadley. An illustrated article calling attention to the opportunities for extension of trade and giving information related. 3000 w. Cassier's Mag—April, 1912. No. 31837 B.

Cost Methods

Cost Methods that Give the Executive Control of His Business. Benjamin A. Franklin. This fifth article of a series discusses labor as the essential element of cost from the cost viewpoint. 2500 w. Engineering Magazine—May, 1912. No. 32341 B.

What Should a Cost System Accomplish? S. E. Nold. Describes its essential features when applied to foundry work. 3000 w. Foundry—April, 1912. No. 31692.

A Simple Cost-Keeping System. E. W. Bernhard. Explains system adaptable to small sized shops. 2000 w. Am Mach—April 4, 1912. No. 31756.

Mining Cost-Chart. Carson W. Smith. A graphical determination of present and future profits and showing the influence of tonnage on costs. 1500 w. Mines & Min—April, 1912. No. 31733 C.

Economics

Is the Study of Economics Useful for the Engineer? Dr. Ernest R. Spedden. Discusses the importance of the economic relation of the engineer to industry and the need of training in the fundamentals of economics. 1500 w. Sib Jour of Engng—April, 1912. No. 32407 C.

Education

Fundamentals in Technical Education. Regis Chauvenet. Discusses the modern tendency toward multiplicity of studies. 6000 w. Mines & Min—April, 1912. No. 31743 C.

The Question of Developing Mechanical Engineers in the Technical High Schools (Zur Frage der Ausbildung der Maschineningenieure an den Technischen Hochschulen). Prof. Schilling. Discusses the advisability of this procedure. 5500 w. Zeitschr des Ver deutscher Ing—Mar. 16, 1912. No. 32042 D.

Questions on Technical Education (Technische Erziehungsfragen). Conrad Matschoff. Outlines some of the principal points to be covered in a complete engineering education. 5200 w. Zeit f Werkzeug—Mar. 15, 1912. No. 32057 D.

Efficiency

Efficiency of Engineering Applied to Mining. Glenville A. Collins. Suggestions for improving conditions. 2000 w. Min & Engng Wld—April 20, 1912. No. 32242.

Engineering Supervision

Notes on the Development of Engineering Supervision for Steel Working Plants. Alex. L. Hoerr. Reviews briefly recent changes in the management of industrial plants, pointing out the value of engineering supervision. 2500 w. Pro Engrs' Soc of W Penn—March, 1912. No. 32123 D.

Engineers

The Work, Aim and Conduct of the Engineer. Charles T. Main. Considers matters of importance to engineers of high standing and essential to success. 9500 w. Jour Assn of Engng Soc—March, 1912. No. 31785 C.

Japan

Great Industrial Development of Kyushu, Japan. Carl F. Deichman. Illustrated account of recent improvements. 5000 w. Far East Rev—Feb, 1912. No. 31867 N.

Labor

Labor's Unrest in the United Kingdom. John B. C. Kershaw. This second article of a series discusses remedies and reforms suggested by a study of conditions. 5000 w. Engineering Magazine—May, 1912. 32348 B.

Sir David Dale; Ironmaster, Conciliator, Arbitrator. James Douglas. An account of the work of a great engineer in reconciling the interests of employer and employee. 7500 w. Engineering Magazine—May, 1912. No. 32339 B.

The Attitude of Labor: A Review. H. F. Buchanan. Aims to point out the causes of restlessness and discontent among the laborers of British collieries, indicating some of the proposed remedies. 4500 w. Col Guard—March 22, 1912. No. 31729 A.

On the Buying of Labor. Jonathan Thayer Lincoln. Read at meeting of Nat. Assn of Cotton Mfrs. Discusses the labor problem and the improvement of conditions. 3500 w. Mfrs' Rec—April 25, 1912. No. 32362.

American and Foreign Wages and Efficiency. W. L. Saunders. Notes based on a recent trip around the world and the

observation of conditions in various countries. 2000 w. Compressed Air—April, 1912. No. 31920.

Management

Scientific Spirit in Management. William C. Redfield. Discusses principles on which scientific management is based. 5000 w. Am Mach—April 18, 1912. No. 32115.

The Place of Motion Study in Scientific Management. Frank B. Gilbreth. An explanation of this plan for eliminating waste. 4500 w. Ap Sci—March, 1912. No. 31780 C.

The Practical Application of Scientific Management to Railway Operation. Wilson E. Symons' closure to the discussion of his paper. 14000 w. Jour Fr Inst—April, 1912. No. 32164 D.

Scientific Management in Use. L. P. Alford. An account of satisfactory results in the shops of the Link-Belt Co. 3000 w. Am Mach—April 4, 1912. No. 31758.

The Vickers System of Management. Notes explaining the system in use at the Barrow Works. 4500 w. Am Mach—April 11, 1912. No. 31859.

Management in the Drafting Room. J. A. Furer. Outlines the system used in a large drafting room. Ills. 3000 w. Am Mach—April 25, 1912. No. 32294.

Monopolies

The Just Value of Monopolies, and the Regulation of the Prices of Their Products. Brief discussion of Joseph Mayer's paper. 900 w. Pro Am Soc of Civ Engrs—March, 1912. No. 32136 F.

Organization

Modern Organization. Charles De Lano Hine. This fifth article of a series discusses supplies and purchases. 2500 w. Engineering Magazine—May, 1912. No. 32344 B.

Industrial Organization's Demands on Business. J. J. Feeley. Reviews history and legislation on the subject. 4500 w. Ir Trd Rev—April 25, 1912. No. 32364.

Patents

The Gist of the Supreme Court Decision in the Dick Patent Case. Gilbert H. Montague. Gives economic and logical reasons for license restrictions. 6000 w. Engineering Magazine—May, 1912. No. 32340 B.

Actual and Constructive Patent Infringement. E. D. Sewall. First of a series of articles discussing this subject. 5000 w. Mach, N Y—April, 1912. Serial. 1st part. No. 31670 C.

Patents. William H. Davis. Discusses mainly patents for the protecting of industrial property in the United States, giving related information of value. 10000 w. Sch of Mines Qr—April, 1912. No. 32157 D.

The Modern Rights of Science (Die Technik im modernen Recht). M. Mintz. Discussion on the patent laws of Ger-

many. 3200 w. Zeit d Oest Ing u Arch Ver—Mar. 22, 1912. No. 32053 D.

A Visit to the Science Museum in London (Ein Besuch im Science Museum in London). Conrad Matschoff. Interesting exhibits of patents during the latter part of the 18th and early part of the 19th century in the London museum. Ills. 4000 w. Zeitschr d Ver deutscher Ing—Mar. 9, 1912. No. 32038 D.

Time Study

Productive Betterment by Time Studies. N. E. Adamson, Jr. Shows how time observations have developed improvements in plant operation, equipment and arrangement. 4000 w. Ir Age—April 4, 1912. No. 31760 C.

Wages

Piece-Work and Bonus Systems in Interborough Rapid Transit Company Shops.

A report of methods of payment introduced in New York City for adopting this system. 3500 w. Elec Ry Jour—April 6, 1912. No. 31848.

Effect of Wage Advances on Employees Compensation. Information from Bul. 28, Bureau of Ry Economics, giving a study for the year ending June 30, 1911. 1500 w. Ry Age Gaz—April 5, 1912. No. 31804.

The Coal Mines (Minimum Wage) Bill. Text of the bill recently introduced in the House of Commons. 2000 w. Col Guard—March 22, 1912. No. 31728 A.

Coal Mines (Minimum Wage) Act. Gives the text of the act which received the Royal Assent on March 29. 2000 w. Col Guard—April 4, 1912. No. 31993 A.

See also Labor, under INDUSTRIAL ECONOMY.

MARINE AND NAVAL ENGINEERING

Barges

The Comparative Costs of Repairs to Barges of Treated and Untreated Timbers; Cost of Timber and Steel Barges Compared. From a paper by A. E. Hageboeck, read before the Am Wood Preservers' Assn. 2000 w. Engng & Con—April 24, 1912. No. 32322.

Steel Barges for Mississippi River Improvement Work. Plan and specifications to which these barges are built. 2500 w. Engng & Con—April 24, 1912. No. 32321.

Battleships

Some Military Principles Which Bear on Warship Design. Sir Reginald Custance. Read before the Inst. of Nav. Archts. Discusses principally gun armament, accuracy of fire in battle, armor and speed. 4500 w. Engng—March 29, 1912. No. 31893 A.

The Battleships of the New "Kaiser" Class. Gives data concerning the building of Germany's first turbine Dreadnoughts. Ills. 1200 w. Engr, Lond—March 29, 1912. No. 31896 A.

Cables

Practical Points on Anchor Cables (Erfahrungen mit Schiffsankerketten). W. Thele. Notes on the breaking point of cables under tension. Ills. 1400 w. Stahl u Eisen—Apr. 4, 1912. No. 32016 D.

Coasting Steamers

Old American Sound and Coasting Steamers. Francis B. C. Bradlee. Illustrates and describes some of the better known old-time steamers. 3500 w. Int Marine Engng—April, 1912. Serial. 1st part. No. 31702 C.

Colliers

The United States Turbine-Driven Naval Collier Neptune. Illustrated description of this vessel and its equipment. 2000 w. Int Marine Engng—April, 1912. No. 31703 C.

Diesel Engines

Diesel Engines for Ocean Ships. George Sherwood Hodgins. Discusses the Diesel type of engine for this service. 1800 w. Marine Rev—April, 1912. No. 32112 C.

The Diesel Oil Engine, Geared Turbine, and Suction Gas Engine. A discussion, introduced by E. L. Orde, before the N. E. Coast Inst. of Engrs & Shipbuilders, on the relative possibilities as compared with the reciprocating engine for marine propulsion. Also editorial. 4500 w. Mech Engr—April 12, 1912. Serial. 1st part. No. 32267 A.

See also Motor Ships, under MARINE AND NAVAL ENGINEERING; and Diesel Engines, under MECHANICAL ENGINEERING, *Combustion Motors*.

Dry Docks

New Steel Floating Dry Docks. Illustrated description of a sectional dock being constructed at Puerto Cabello for the Venezuelan government. 700 w. Marine Rev—April, 1912. No. 32111 C.

Electric Power

The Electric Propulsion of Ships (Elektrischer Antrieb von Schiffen). W. Wolf. Discusses the arrangement of motors, etc., for applying the electric drive in ships. Ills. Serial. 1st part. 5600 w. Schiffbau—Mar. 13, 1912. No. 32035 D.

Gas Power

Gas Power for Ship Propulsion. A. C. Holzapfel. Read before the Inst. of Nav. Archts. Reviews early attempts and gives detailed description and information concerning the gas-driven vessel "Holzapfel I." Ills. 4000 w. Mech Engr—March 29, 1912. No. 31888 A.

Sea-Going Producer Gas-Driven Cargo Vessel Holzapfel I. F. C. Coleman. Plans and description of this gas-powered boat. 3000 w. Int Marine Engng—April, 1912. No. 31701 C.

Launching

Ships Launching in Stralsund Harbor (Schiffsaufschleppvorrichtung in Stralsund-Hafen). W. Schrader. Describing the mechanical appliances, runways, etc., in use for launching small ships. Ills. 1600 w. Schiffbau—Mar. 27, 1912. No. 32037 D.

Liberte

Plans for Raising the Wreck of the Cuirasse "Liberté" (Projets d'Enlèvement de l'Epave du Cuirassé "Liberté"). René Sabines. Presenting the reasons for the removal of the wreck from the Toulon harbor, and outlining several plans for its accomplishment. Ills. 4000 w. Genie Civil—Mar. 16, 1912. No. 32098 D.

Model Tanks

The William Froude National Tank. G. S. Baker. Read before the Inst. of Nav. Archts. Supplement to a paper read last year. The present paper describes in detail the small tank, built as an annex to the main tank, which was previously described. Ills. 2000 w. Engng—March 29, 1912. No. 31892 A.

Motor Ships

Success of the First Large Diesel Motor-Driven Motor. J. Rendell Wilson. Illustrated account of the success of the motor ship "Selandia," describing the Diesel engines and their working. 1200 w. Int Marine Engng—April, 1912. No. 31700 C.

Results of Trials of the Diesel-Engined Sea-Going Vessel "Selandia." G. Knudsen. Read before the Inst. of Nav. Archts. Describes the engines and reports results of the first practical trial. 1200 w. Engng—April 5, 1912. No. 31995 A.

Navies

Modern Navies (Les Flottes de Guerre Modernes). M. Gouriet. Comparisons of the leading navies of the world. Serial. 1st part. Ills. 4000 w. Genie Civil—Mar. 23, 1912. No. 32300 D.

Navigation

Turning Circles. William Hovgaard. Read before the Inst. of Nav. Archts. Gives an analysis of a number of turning trials aiming to establish the equations of motion for the final turning circle and to give formulae and co-efficients for the determination of its diameter. 9000 w. Engng—March 29, and April 12, 1912. Serial. 2 parts. No. 32272 each A.

Propellers

Increased Efficiency in Propellers (Erhöhung des Wirkungsgrades der Schiffsschrauben). Herr Euterneck. Notes on the theory of propeller blades. Diagrams. Serial. 1st part. 3600 w. Schiffsbau—Mar. 27, 1912. No. 32036 D.

Propulsion

Alternative Systems of Propelling Ships. Editorial review of papers read before the Inst of Nav. Archts. 3500 w. Engng—April 5, 1912. No. 31997 A.

See also Electric Power, under MARINE AND NAVAL ENGINEERING.

Revenue Cutters

The Revenue Cutter Service. Reviews the history of this service. Ills. 2500 w. Marine Rev—April, 1912. No. 32113 C.

Salvage Docks

French Salvage Dock for Submarines. Illustrated description. 600 w. Engng—April 12, 1912. No. 32274 A.

Shipbuilding

The Shipbuilding Industry of Germany. Count Ernst von Reventlow. Reviews marine and naval development in Germany. Ills. 9000 w. Cassier's Mag—April, 1912. No. 31836 B.

Ship Form

Waves and Ship Form. Arthur R. Liddell. A study of deep-water and sea conditions and the proportions of vessels admissible. 2200 w. Engr, Lond—April 5, 1912. No. 32101 A.

Steam Boilers

Results of Experiments with a Water-Tube Boiler, with Special Reference to Superheating. Harold E. Yarrow. Read before the Inst. of Nav. Archts. Gives results of recent important experiments. Ills. 3000 w. Mech Engr—April 5, 1912. No. 31990 A.

On the Solignac-Grille Boiler and Its Application in French Channel Steamers. G. Hart. Read before the Inst. of Nav. Archts. Explains the reasons which led to the employment of a device for insuring a regular circulation, illustrates and describes this boiler and its installation on the torpedo-boat "Kabyle," the "Le Nord" and "Pas de Calais." 6000 w. Engng—April 5, 1912. No. 31999 A.

Steamships

Performance on Service of the Channel Steamer "Newhaven." P. Sigaudy. Read before the Inst. of Nav. Archts. Gives service results of this steamer during the first five months on the route between Newhaven and Dieppe. 700 w. Engng—April 12, 1912. No. 32281 A.

The Twin-Screw Steamship "Koningin der Nederlanden" (Hed dubbelschroefstoomschip "Koningin der Nederlanden"). J. H. C. Salberg. Detailed description of the design, construction and appointments of this ship. Ills. and plates. Serial. 1st part. 9200 w. De Ingenieur—Mar. 30, 1912. No. 32074 D.

Launching Investigations and Measurements of the Twin-Screw Steamer "Bahia Blanca" (Stappellaufuntersuchungen und Messungen D. S. D. "Bahia Blanca"). Carl Commentz. A series of research diagrams on the pressure conditions to be met in launching a ship. Ills. 2800 w. Schiffbau—Mar. 13, 1912. No. 32034 D.

"Titanic" Disaster

The Wreck of the "Titanic": Its Effect on Transatlantic Steamship Routes. Also editorial. Map. 4000 w. Eng News—April 25, 1912. No. 32371.

Wreck of the White Star Liner "Titanic." An illustrated account of the

loss of this great steamship. 2500 w. Sci Am—April 27, 1912. No. 32332.

The Story of the "Titanic" Wireless. The story as told by Harold Bride, the assistant operator, with editorial note. 2000 w. Elec Rev & W Electn—April 27, 1912. No. 32403.

Turbines

Parsons' Steam Turbines for an 18-Knot Ocean Liner. Illustrated detailed description of turbines designed to develop 16500 shaft h. p. when running 290 revolutions per minute, and to give the boat a speed of 18 knots. 2 plates. 3000 w. Engng—March 22, 1912. No. 31730 A.

Curtis Marine Steam Turbines. Illustrates and describes details of the designs. 2000 w. Mech Engr—April 12, 1912. No. 32265 A.

Steam Turbines of 4,500 to 5,600 Horsepower (La Turbina a Vapore di 4,500-5,600 H. P.). A general description of the Tosi turbine. Plates. 1200 w. Industria—Mar. 30, 1912. No. 32311 D.

The "Tosi" Marine Steam Turbine (La Turbina a Vapore "Tosi" Marina). Francesco Modugno. Description and applications of this turbine on Italian vessels. Ills. 9000 w. Rivista Marittima—Feb., 1912. No. 32302 E + F.

Turbine Steamers

The Geared Turbine Channel Steamers "Normannia" and "Hautonia." J. H. Biles. Read before the Inst. of Nav. Archts. Describes the completed ship and gives the history of the design and results of trials. 2000 w. Engng—April 12, 1912. No. 32280 A.

MECHANICAL ENGINEERING

AERONAUTICS

Aerodynamics

Observations on the Flight of the Herring Gull. James E. Fraser. An illustrated nature study in aviation. 2500 w. Sci Am Sup—April 20, 1912. No. 32177.

Aviation

Aviation in the Sahara. M. P. James. Translated from *l'Aerophile*. Considers the difficulties, especially the protection of the motor against dust. Ills. 2000 w. Sci Am Sup—April 6, 1912. No. 31772.

Bracing

Stresses in Aeroplane Stays. Condensed paper by Captain Largier, before Inst. of Civ. Engrs. of France, on "The Torsion Meter," showing how stay stresses may be measured on an aeroplane in actual flight. 1700 w. Engr, Lond—April 12, 1912. No. 32286 A.

Exhibitions

The Third Paris "Salon d'Aéronautique" (Die III Pariser "Salon d'Aéronautique"). Dr. V. Quittner. Review of some types on exhibit. Ills. 2000 w. Zeit d Oest Ing u Arch Ver—Mar. 22, 1912. No. 32054 D.

Military

British Military Aeroplanes (Der britische Militär-Aeroplan). Rudolf Kommer. Reviews the requirements adopted by the Government for the various service types. 2000 w. Motorwagen—Mar. 10, 1912. No. 32059 D.

The Albatross Military Biplane, Model 1911 (Der Albatros-Militär-Doppeldecker, Type 1911). Franz Klee. Details in the design of this two-passenger type. Ills. and plates. 1200 w. Motorwagen—Apr. 14, 1912. No. 32316 D.

Motors

Results and Significations from Tests on Aviation Motors (Résultats et Interprétation d'Essais de Moteurs d'Aviation).

M. G. Lumet. Conditions for the adaptation of motors for use on aeroplanes. Ills. 7000 w. Mem Soc Ing Civ de France—Jan., 1912. No. 32082 G.

Propellers

Driving Blades (Die Triebsschraube). R. Soreau. Mathematical discussion on the theoretic design of aeroplane propellers. Diagrams. Serial. 1st part. 2000 w. Die Turbine—Mar. 20, 1912. No. 32002 D.

AUTOMOBILES

Ball Bearings

Failure of Ball Bearings. J. V. Pugh. Read before the Inst. of Auto. Engrs. Critical discussion of G. F. Barrett's paper on "The Causes of Failure in Ball Bearings." Ills. 2200 w. Auto Jour—April 13, 1912. No. 32251 A.

Brasier

The 12 H. P. Brasier. Illustrates and describes the main features of interest in this car. 2000 w. Auto Jour—March 23, 1912. No. 31717 A.

Design

Some Possible Developments of the Motor Car. H. C. Clark. Read before the Coventry Engng Soc. Discusses modern requirements and expected developments. 9000 w. Autocar—March 23, 1912. No. 31716 A.

Electrical Devices

The How and Why of Electrical Devices Familiar to Automobilists. Joseph B. Baker. The present article explains the relations to magnetism and electricity in experiment and practice. Ills. 2000 w. Automobile—April 4, 1912. Serial. 1st part. No. 31794.

Electric Vehicles

Electric Vehicles Research at the Massachusetts Institute of Technology. Reports a study to determine comparative costs of operating electric, gasoline, and

horse vehicles. 2500 w. Elec Wld—April 6, 1912. No. 31850.

Electric Vehicle Controlling Systems. Harry E. Dey. Illustrates and describes some of the speed changing methods in use in electric vehicles. 1500 w. Horseless Age—April 10, 1912. Serial. 1st part. No. 31926.

Engines

The Horse Power of Automobile Engines. F. E. Watts. A discussion of the work done in England to arrive at a satisfactory formula for engine output, and some data of recent American engines. 2500 w. Horseless Age—April 17, 1912. No. 32170.

Garages

The Portable Garage: Synonym for Economy and Convenience. Illustrated article describing various types and giving information. 5000 w. Automobile—April 11, 1912. No. 31932.

Ignition

Ignition Timing. An illustrated study of the time of lag of coil and magneto sparks. 1000 w. Autocar—April 13, 1912. No. 32248 A.

Lancia

The 15 h. p. Lancia. Reviews the interesting points of design in this car. Ills. 1200 w. Autocar—March 30, 1912. No. 31874 A.

Locks

Detachable Wheel Locks. Bertram C. Joy. Illustrates and describes locking devices in use. 3000 w. Autocar—April 13, 1912. No. 32249 A.

Lozier

Lozier Type 72. Illustrated description of a new 6-cylinder model with steering wheel to the left and levers in the center for right-hand control. 3500 w. Automobile—April 18, 1912. No. 32204.

Lubrication

The Question of Bearings and Oiling of Motors and Motor Cars (Zur Frage der Lager und Schmierung von Motoren und Motorwagen). Aug. Bauschlicher. General remarks on these debatable points. Serial. 1st part. 1400 w. Motorwagen—Apr. 14, 1912. No. 32317 D.

Metallurgique

The 14-H. P. Metallurgique Landulette. Illustrated description of a closed car of recent design. 2000 w. Auto Jour—April 6, 1912. No. 31983 A.

Mud-Guards

The Mud-Guard Competition of the Automobile Club (Le Concours de Pare-Boue de l'Automobile Club). E. Bret. Tests on various mud-guard applications determined by the height of splash through a specially prepared muddy section. Ills. and plate. 7200 w. Genie Civil—Mar. 9, 1912. No. 32094 D.

Napier

The 45-H. P. Napier. An illustrated description of this chassis, which combines strength, efficiency and absence of noise.

2500 w. Auto Jour—April 13, 1912. No. 32250 A.

Peugeot

The 17-22 H. P. Peugeot. Illustrated description of a 4-cylinder, 4-speed car with arched back axle and spring drive. 1200 w. Autocar—March 23, 1912. No. 31715 A.

Radiators

Methods of Radiator Suspension. C. T. Schaefer. Explains how the radiators of motor trucks are protected against road vibration and the effects of distortion of their frames. Ills. 1500 w. Horseless Age—April 10, 1912. No. 31925.

Repairs

Caring for Tires, Wheels and Rims. Suggestions for repairing punctures, locating leaks, etc. Ills. 3800 w. Automobile—April 18, 1912. Serial. 1st part. No. 32203.

Stoewer

The 15-20 H. P. Stoewer Car. Illustrated detailed description. 1500 w. Auto Jour—March 30, 1912. No. 31875 A.

Trucks

New Suburban Truck Has Worm Drive. Illustrated description of a vehicle placed on the market by the Suburban Motor Truck Co., Phila. 1500 w. Horseless Age—April 17, 1912. No. 32171.

COMBUSTION MOTORS

Diesel Engines

A New Diesel Engine Formula. P. A. Holliday. Develops formula and illustrates by example. 7000 w. Engr, London—April 5, 1912. No. 32100 A.

The Diesel Oil-Engine, and Its Industrial Importance, Particularly for Great Britain. Dr. Rudolph Diesel. Illustrated review of its development and applications, discussing questions of general importance. 15000 w. Inst of Mech Engrs—March 15, 1912. No. 31723 N.

The Diesel Engine. S. M. Howell. Illustrated description of the self-igniting system of operation of Diesel engines. 2500 w. Mach, N Y—April, 1912. No. 31668 C.

See also same heading under MARINE AND NAVAL ENGINEERING.

Engine Rating

American Practice in the Rating of Internal Combustion Engines. T. C. Ulbricht and C. E. Torrance. Gives curves and equations, based on an investigation of over 600 different sizes and types of machines, showing average current practice in America. 800 w. Sib Jour of Engng—April, 1912. No. 32406 C.

Gas Engines

Increasing the Capacity of Large Gas Engines. Gives summary of results from investigations by Wilhelm Hellmann, as given to the Soc. of German Engrs. Ills. 1500 w. Prac Engr—April 12, 1912. Serial. 1st part. No. 32260 A.

Temperature of Gas-Engine Cylinders. John Batey. Considers its effect on the

power factor and upon heat efficiency. 1800 w. Cassier's Mag—April, 1912. No. 31832 B.

General Management of Gas Engines and Their Troubles. A. L. Brennan, Jr. Detailed study of gas engines and their management. 4000 w. Rudder—April, 1912. Serial. 1st part. No. 31788 C.

Gas Producers

Points Concerning Producer Plants. C. F. Publow. Describes producer plant installation and operation in detail. 4500 w. Ap Sci—March, 1912. No. 31783 C.

Vertical Retorts for Continuous Distillation (Corunes Verticles a Distillation Continue). E. Lemaire. A study of the Woodall-Duckham or Bournemouth system, with special attention to the Lausanne gas plant. Ills. and plate. 6000 w. Genie Civil—Mar. 23, 1912. No. 32099 D.

Oil Engines

Oil Engines in a Hungarian Municipal Power Plant. Abstract of a paper by Laszlo Bano, read before the Hungarian Soc. of Engrs. & Archts. of Budapest. Illustrates and describes features of two 300 h. p. engines in the plant at Torda (Hungary). 1700 w. Power. April 16, 1912. No. 31977.

Experiments on the Utilization of Waste Heat with a Sulzer 300 H. P. Diesel Engine (Versuche an einer Sulzerschen 300 pferdigen Dieselmotorenanlage mit Abwärmeverwertung). J. Cochand and M. Hottinger. Describes apparatus and results of tests. Ills. 3800 w. Zeitschr des Ver deutscher Ing—Mar. 23, 1912. No. 32044 D.

See also Diesel Engines, under *Combustion Motors*, and under *MARINE AND NAVAL ENGINEERING*.

Reversing Devices

Reversing Gas and Oil Engines. A. M. Levin. Illustrates and describes a number of methods for making combustion engines reversible. 3500 w. Power—April 2, 1912. No. 31712.

Valves

Rotary Valves for Explosion Engines. Henry Souther. Explains the theory, design, and construction. Ills. 2000 w. Am Mach—April 25, 1912. No. 32296.

HEATING AND COOLING

Central Plants

The Central Heating Station at the University of Manchester. Illustrated description of a plant for heating a group of buildings. 1200 w. Engng—April 12, 1912. No. 32276 A.

Hot Water Heating for the Central Station. Ira N. Evans. Discusses central station heating for cities and towns, and the requirements of large institutions and manufacturing plants. 4500 w. Power—April 30, 1912. No. 32438.

Drying

Drying Apparatus. H. C. Russell. From a paper read before the Am. Soc. of Heat & Vent Engrs. Calls attention to

principles underlying the design of drying apparatus. Also discussion. 3500 w. Heat & Vent Mag—April, 1912. No. 31879.

Factories

Heating and Ventilating a Large Factory. An account of a large rubber factory heated in winter and cooled in summer by water circulated through Green fan blast heaters. Ills. 1500 w. Ir Age—April 4, 1912. No. 31763 C.

Factory Heating From Fuel-Saving Angle. William J. Baldwin and Ralph C. Taggart. Discusses important questions to be considered in deciding the general design and arrangement of the heating apparatus. Ills. 4000 w. Ir Age—April 25, 1912. No. 32330 C.

Hospitals

Heating and Ventilating of Hospital Ward Buildings. Charles L. Hubbard. Considers especially ward buildings of cottage hospitals steam heated from a central plant. Ills. 2500 w. Dom Engng—April 13, 1912. No. 31980.

Plumbing

Warming and Plumbing House on a Hill. Illustrations, plans and description of windmill water supply, septic tank sewage disposal, and hot-water heating system. 2000 w. Met Work—April 26, 1912. No. 32360.

Refrigeration

Ammonia Absorption Refrigerating System. Fred Ophuls. Outlines sketch and description. 5000 w. Power—April 23, 1912. No. 32247.

Faulty Versus Proper Insulation. C. D. Havenstrite. Read before the W. Ice Mfrs. Assn. Discusses types old and new, considering heat transmission, moisture, and structural strength. 4500 w. Ice & Refrig.—April, 1912. No. 31814 C.

Filtration and Lubrication. H. H. McClintock. Read before the W. Ice Mfrs. Assn. Gives experience at a certain plant, explaining conditions and results accomplished. 1200 w. Ice & Refrig—April, 1912. No. 31815 C.

The Future Outlook for the Refrigeration Industry (L'Avenir de l'Industrie du Froid). M. L. Rey. Abstracts from paper read before the *Société des Ingénieurs civils de France*, presenting causes for further improvement in refrigeration. 4000 w. Rev d'Econ Indus—Mar. 20, 1912. No. 32074 D.

Schools

Heating and Ventilating of Schools. Conclusions of a special committee of the Am. Soc. of Heat. & Vent. Engrs. on present standards of temperature, air purity, and air currents, with standard form of tests. 3000 w. Met Work—April 26, 1912. No. 32361.

Ventilation

Ventilating Equipment of a Laundry. Illustrates and describes arrangements for the removal of moisture-laden air and the

supply of fresh air. 2500 w. Met Work—April 12, 1912. No. 31918.

HYDRAULIC MACHINERY

Compressed Air Pumps

Pumping by Compressed Air. Herbert T. Abrams. Illustrated discussion of each of the four methods of using compressed air for lifting water. 2500 w. Sch of Mines Qr—April, 1912. No. 32160 D.

Hydraulic Jacks

The Care and Repair of Hydraulic Jacks. Arthur J. Humphrey. Describes the principle upon which all types of jacks work and the methods of repairing. Ills. No. 31676 C.

Pumps

Recent Improvements in Turbine Sinking Pumps. Explains difficulties that have been recently overcome or lessened. Ills. 2500 w. Ir & Coal Trds Rev—March 29, 1912. No. 31903 A.

The Stereophagus Pump. Illustrated description of a centrifugal pump designed to deal with unscreened sewage. 1600 w. Engng—April 5, 1912. No. 31994 A.

Canalization of Waste Waters by Centrifugal Pumps (Canalisation des eaux d'égout par pompes centrifuges). Ed. Henry. Description of the Stereophagus system utilizing the Parsons turbine. Ills. 3000 w. Rev. Industrielle—Mar. 23, 1912. No. 32301 D.

The Delphin Pump and Its Uses (Das Delphinpumpwerk und seine Anwendung). Paul Kurgass. Description of this self-operating pump and its commercial possibilities. Ills. 3800 w. Zeitschr. der Ver deutscher Ing—Mar. 16, 1912. No. 32043 D.

The Abraham Hydropulsator (L'idropulsator Abraham). F. Giordano. Description and application of this pump. Ills. 2100 w. L'Industria—Mar. 17, 1912. No. 32310 D.

Resistances

The Law of Comparison for Surface Friction and Eddy-Making Resistances in Fluids. T. E. Stanton. Read before the Inst. of Nav. Archts. Refers to the law of surface friction as discovered by Osborne Reynolds, discussing its application to hydraulic resistance determinations in turbines. 1800 w. Engng—March 29, 1912. No. 31894 A.

Riveting

Hydraulic Riveting. H. J. Hartley. Read before the Am. Boiler Mfrs.' Assn. Discusses hydraulic pressures as applied to riveting. 2000 w. Boiler Maker—April, 1912. No. 31856.

Turbines

Hydraulic Turbines for the White River Plant. Arnold Pfau. Illustrated description of units for a delivery of 18000 h. p. under a head of 440 ft. and able to supply 20,400 h. p. under a 480 ft. head, installed near Tacoma, Wash. 3000 w. Eng Rec—April 20, 1912. No. 32198.

The Largest Hydraulic Turbines in the World. Arnold Pfau. Illustrates and describes the principal features of the hydraulic equipment of the White River plant, and states the reason for their adoption. 4500 w. Eng News—April 18, 1912. No. 32211.

Dimensions of Turbine Intake Pipes (Die Dimensionierung von Turbinenrohrleitungen). J. Magg. Diagrammatic studies of the proper size for intake pipes from the reservoir to the plant. Ills. 3000 w. Die Turbine—Mar. 20, 1912. No. 32001 D.

The Highest Practical Rotary Speed of Francis Turbines (Die erreichbare höchste spezifische Drehzahl von Francis-turbinen). G. Reindl. Mathematical discussion with aid of diagrams. 2000 w. Zeit f d ges Turbinenwesen—Mar. 10, 1912. No. 32003 D.

Turbo-Pumps

Comparing Turbo-Pumps, Blowers. Charles A. Carpenter. Comparison, by reducing to a basis of unit speeds, for the purpose of selecting the most economical unit. 1000 w. Power—April 30, 1912. No. 32435.

Water Wheels

See Water Power, under ELECTRICAL ENGINEERING, *Generating Stations*.

MACHINE ELEMENTS AND DESIGN

Band Brake

Design of a Band Brake. T. W. Hollo-way. Gives formulae applied to an actual case. 1500 w. Am Mach—April 4, 1912. No. 31755.

Cams

Gas Engine Cam Design. C. M. Mohler. A criticism of the existing type and advocating a noiseless type. 1500 w. Am Mach—April 4, 1912. No. 31753.

Patterns

Plaster Patterns. A short description of methods used in plaster pattern-making. Ills. 1000 w. Mech Wld—March 22, 1912. No. 31724 A.

The Pattern Maker and the Core-room. Jabez Nall. Illustrated discussion of the relations. 3000 w. Am Mach—April 4, 1912. No. 31759.

Piston Rings

Making Piston Rings. C. A. Rogers. Illustrates and describes the method of manufacture. 900 w. Mach, N Y—April, 1912. No. 31675 C.

Special Tools

Combination Designs of Machine Tools. Joseph Horner. Illustrated descriptions of special tools for a variety of work. 4500 w. Cassier's Mag—April, 1912. No. 31834 B.

Toolholders

Toolholders. George W. Burley. Considers the effect of high speed tool steels on the design of holders for cutting tools, illustrating and describing forms. 2500 w. Mech. Wld—April 5, 1912. Serial. 1st part. No. 31915 A.

MACHINE WORKS AND FOUNDRIES**Accident Prevention**

The Prevention of Accidents in Foundries. W. H. Cameron. Read before the Pittsburgh Found. Assn. Reports what has been accomplished by the methods of the Am. Steel Foundries. Ills. 4500 w. Ir Age—April 4, 1912. No. 31767 C.

See also Safety Devices, under *Machine Works and Foundries*.

Aluminum Castings

Use of Green Sand Cores in Aluminum Work. Illustrates and describes methods of making successful aluminum castings. 3500 w. Foundry—April, 1912. No. 31695.

Assembling

A Problem in Gang Assembling. H. M. Wilcox. A progressive study of an interesting assembling job in the manufacture of insulator joints. Ills. 2000 w. Am Mach—April 18, 1912. No. 32120.

Boring Machines

Precision Boring Machine. Illustrates and describes details of a horizontal boring, drilling and milling machine and its vertical milling attachment. 2000 w. Ir Age—April 4, 1912. No. 31765 C.

See also Milling Machines, under *Machine Works and Foundries*.

Brass Founding

Melting Borings and Wire Brass. Walter J. May. Suggestions for care necessary to avoid waste. 800 w. Mech Wld—March 22, 1912. No. 31725 A.

Case-Hardening

Case-Hardening Methods and Mixtures. Notes from a paper by Dr. L. Guillet, published in *Le Genie Civil*, on "The Present Condition of the Theory and Practice of Case-Hardening." 2000 w. Ir Age—April 11, 1912. No. 31931 C.

Castings

The Manufacture of Accurate Soft Metal Castings in Metal Molds, With Note on Making of the Mold. Ills. 1000 w. Brass Wld. April, 1912. No. 32121.

Results of Manganese Bronze Experiments. C. Vickers. Discusses the conditions of molding and casting. 1500 w. Foundry—April, 1912. No. 31696.

Emergency Jobs with Inexpensive Riggings. Describes how large castings were molded and cast at a minimum expense. Ills. 1500 w. Foundry—April, 1912. No. 31693.

Notes on the Relation in Size and Strength between Test-Pieces and Castings (Betrachtungen über den Zusammenhang der Abmessungen und Festigkeits-Ergebnisse zwischen Probestäben und Gussstücken). J. and L. Treuheit. Including remarks on the variability of test-bars. Ills. 3800 w. Stahl u Eisen—Mar. 28, 1912. No. 32012 D.

The Exhibition of Old Cast-Iron Plates Considered from the Standpoint of Historic Skill (Die Darstellung auf alten gusseisernen Ofenplatten vom Stand-

punkte des Kunsthistorikers betrachtet). J. Lasino. Illustrated review showing the early practice in decorative iron castings from the end of the 15th century to later years. 4200 w. Stahl u Eisen—Mar. 28, 1912. No. 32013 D.

Chain Making

Chain-Making Machinery. Illustrated detailed description of methods old and new, the machinery used, improvements, new processes, etc. 5500 w. Ir & Coal Trd Rev—April 5, 1912. No. 32103 A.

Cutters

Setting Double-Angle Fluting Cutters. George W. Burley. Describes a method of setting the fluting mill with respect to the cutter blank without recourse to the use of a rule. Supplement. 1200 w. Mach, N Y—April, 1912. No. 31672 C.

Drills

See Tools, under *Machinery Works and Foundries*; and same heading, under MINING AND METALLURGY, *Mining*.

Drying

See same heading, under *Heating and Cooling*.

Engraving

Brass Engraving by Machinery. Chester L. Lucas. Illustrated description of an engraving machine and its work. 900 w. Mach, N Y—April, 1912. No. 31671 C.

Foundries

See Shops, under STREET AND ELECTRIC RAILWAYS.

Foundry Practice

Mixing and Melting Iron Scientifically. David McLain. Explains why iron should be mixed by analysis rather than by grade. 3500 w. Foundry—April, 1912. No. 31698.

Fastening Cores to the Bottoms of Moulds. Walter J. May. Suggestions for securing successful castings. 1000 w. Prac Engr—April 5, 1912. No. 31985 A.

Economic Machine Operation in Foundries (Maschinenwirtschaft in Hüttenwerken). H. Hoffmann. The first article discusses the economy obtained by the use of gas-engines. Ills. Serial. 1st part. 4000 w. Zeitschr des Ver deutscher Ing—Mar. 16, 1912. No. 32039 D.

See also Car Wheels, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Furnaces

Continuous Oil or Gas-Fired Heating Furnaces. Illustrated description of the Gordon-Prall furnace. 800 w. Ir Trd Rev—April 25, 1912. No. 32365.

Furnace Regulation

Balanced Draft Furnace Regulation. Warren O. Rogers. Describes a system for maintaining atmospheric pressure in a boiler furnace. Ills. 1200 w. Power—April 9, 1912. No. 31854.

Galvanizing

The Sherardizing Process. Oliver W. Storey. Explains this process for the prevention of rust and describes methods

used at Economy, Pa. 4000 w. Wis Engr—April, 1912. No. 32409 C.

Gear Cutting

Hobbing Helical Gears without a Differential Gear. Will. O. Wynne. Detailed description of the procedure. Ills. 1000 w. Prac Engr—March 29, 1912. No. 31886 A.

Gear Generating Machine. The present article illustrates and describes Wall-work's gear hobbing machine. 700 w. Prac Engr—April 12, 1912. Serial. 1st part. No. 32261 A.

Lathes

Two Large Shafting Lathes. Illustrates an 80-ft. lathe with single bed, giving brief description. 500 w. Engr, Lond—March 29, 1912. No. 31899 A.

Duplex Lathe for Railway Wheels, and Quadruple-Geared Lathe Headstock. Illustrates and describes two recent machine tools of English make. 500 w. Engng—April 12, 1912. No. 32279 A.

See also Tools, under *Machine Works and Foundries*.

Lathe Work

An Interesting Job on the Gridley Automatic Turret Lathe. Chester L. Lucas. Illustrated description of the making of a 3-inch shrapnel shell on the 3¼-inch single-spindle machine. 1000 w. Mach, N Y—April, 1912. No. 31666 C.

Machine Tools

Air Valve, Piston and Bushing Work. Ethan Viall. Illustrated description of multiple-spindle profiling machines and their work. 2000 w. Am Mach—April 25, 1912. No. 32292.

Double Column Horizontal Boring, Drilling, Facing, Tapping, and Studding Machine. Illustration, with brief description. 500 w. Engng—March 29, 1912. No. 31891 A.

Milling Machines

A New System for Locating Holes to be Bored on the Milling Machine. George J. Murdock. Describes a system where a center-punch mark takes the place of the button from which to indicate the work. Ills. 2500 w. Mach, N Y—April, 1912. No. 31665 C.

Milling Machines and Their Work. Joseph G. Horner. Reviews their development, the requirements of present practice and some recent designs. 2500 w. Prac Engr—March 29, 1912. Serial. 1st part. No. 31885 A.

Molding

Arrangement of the Cupola for Continuous Pouring. Illustrated description of a novel installation in Davenport, Iowa. 1000 w. Castings—April, 1912. No. 32200.

Planers

Milling Operations on the Planer. Glenn Muffy. Illustrates and describes applications of a milling attachment to special work on the planer. 700 w. Am Mach—April 4, 1912. No. 31752.

Repairing Planers and Shapers. Edward K. Hammond. Illustrates and describes the practice of a Chicago company making a specialty of such work. 3000 w. Mach, N Y—April, 1912. No. 31667 C.

See also Tools, under *Machine Works and Foundries*.

Rolls

Grinding and Corrugating Rolls. F. A. Stanley. Methods of handling chilled iron rolls in an Omaha shop are described. Ills. 800 w. Am Mach—April 11, 1912. No. 31861.

Safety Devices

Prevention of Industrial Accidents. Frederick Remsen Hutton. Illustrates and describes a number of safety devices. 2500 w. Mach, N Y—April, 1912. No. 31669 C.

Industrial Accidents and Their Prevention. Gives statistics showing the importance of accident prevention, and illustrates and describes appliances and methods that have given satisfactory results. 2500 w. Sci Am Sup—April 6, 1912. No. 31771.

Safety Appliances and Injury to Employees. W. O. Thompson. Discusses the question of safety appliances for the mechanical and car departments of railroads. Ills. Discussion. 10000 w. Pro Cent Ry Club—March 8, 1912. No. 32148 C.

See also Cranes, under *Transporting and Conveying*.

Shop Practice

Making Engineering Instruments. Fred H. Colvin. Illustrates and describes methods used at a shop in Denver, Colo. 1500 w. Am Mach—April 4, 1912. No. 31757.

Manufacturing on Precision Machines. Illustrated description of unusual milling operations. 700 w. Am Mach—April 18, 1912. No. 32116.

Grinding in, Lapping, Etc. Diagram and descriptions of methods used. 1200 w. Mech Wld—March 29, 1912. No. 31887 A.

Making an Expansion Boring Tool. Illustrated description of shop operations in a St. Louis plant. 1800 w. Ir Age—April 11, 1912. No. 31929 C.

Manufacturing Cream Separators. F. A. Stanley. Illustrates and describes standard and special tool equipment and methods used in an Iowa manufacturing shop. 1500 w. Am Mach—April 25, 1912. No. 32291.

A Missouri Gas Engine Factory. F. A. Stanley. Illustrates and describes tools and methods used in a Kansas City, Mo., shop. 1200 w. Am Mach—April 4, 1912. No. 31751.

Methods in a Gasoline Engine Shop. F. A. Stanley. Illustrates and describes tools and methods used in an Iowa factory. 1200 w. Am Mach—April 18, 1912. No. 32114.

Making the Jacobs-Shupert Firebox. J. F. Whiteford. Illustrates and describes forms and dies used which simplify the manufacture. 800 w. Am Mach—April 18, 1912. No. 32119.

Methods in 'Frisco Railroad Shops. Illustrates and describes methods and appliances. 800 w. Am Mach—April 25, 1912. No. 32295.

Shops

The Sulzer Works at Winterthur, Switzerland. Illustrations and notes of an important Continental plant. 500 w. Engineering Magazine—May, 1912. No. 32343 B.

The Sterling Telephone Works, Dagenham, Essex. Illustrated account of these new works. 1800 w. Elec Rev, Lond—April 12, 1912. No. 32252 A.

A Somersetshire Engineering Works. Illustrated description of the Nautilus works, Yeovil, and their operation and equipment. 3000 w. Engr, Lond—April 5, 1912. No. 32102 A.

New Structural Shop of the Hay Foundry & Iron Works at Newark. Illustrates and describes details of a steel and concrete building with two aisles, equipped with girder cranes and traveling wall jib cranes. 3000 w. Eng Rec—April 27, 1912. No. 32389.

A Modern Plant for the Manufacture of Boilers and Heavy Steel Plate Work. Illustrated description of a shop in Cleveland, Ohio. 1800 w. Boiler Maker—April, 1912. No. 31855.

Tools

Some Special Tools of British Design. Illustrated descriptions of a lathe, planer-slotting machine, and special radial drill. 3500 w. Prac Engr—April 5, 1912. No. 31986 A.

Subpress Tools for Watch Rollers. A. M. Cahill. Gives details of the making of a precision die for watch work. Ills. 2700 w. Am Mach—April 18, 1912. No. 32118.

Welding

The Theory of Steel Welding and Some Practical Applications (Die Theorie des Schweissens von Stahl und ihre praktische Anwendung). Max Bermann. Review of some modern methods with illustrations of results obtainable. 7200 w. Zeitschr des Ver deutscher Ing—March 30, 1912. No. 32047 D.

Wood Planing

Eight-Roller Wood-Planing Machine. Illustrated description of a recent English design which adopts the use of eight rolls. 1200 w. Engr, Lond—April 12, 1912. No. 32285 A.

MATERIALS AND CONSTRUCTION

Alloy Steels

Concerning Alloys (Ueber Legierungen). Hugo Kühl. Review of present practice in the manufacture of alloy steels. Serial. 1st part. 1400 w. Giesserei Zeit—April 1, 1912. No. 32019 D.

Cast Iron

Segregation and Shot in Iron. E. L. Rhead. Abstract of paper read before the British Found. Assn. Discusses the physical properties, carbon concentration, and related matters. 2000 w. Foundry—April, 1912. No. 31699.

Corrosion

See Steel, under *Materials of Construction*; and Pipe Corrosion, under *CIVIL ENGINEERING, Water Supply*.

Steel

The Influence of Carbon on the Corrosion of Steel. Reports concerning tests being made by a committee of the British Assn. for the Adv. of Science. 2500 w. Eng Rec—April 20, 1912. No. 32190.

Analysis Variations in Steel. E. F. Davis. Gives some chemical analyses of steel shipped on specification, and shows the importance of analysis when the steel is received. 1800 w. Am Mach—April 4, 1912. No. 31754.

Microscopic Analysis of Steel in Forgings. E. F. Lake. Illustrated discussion of the effects of various heat treatments and the necessity for microscopic examination. 3500 w. Horseless Age—April 3, 1912. No. 31790.

Segregation in Steel. Charles L. Huston. From a paper read before the Am. Boiler Mfrs.' Assn. Considers steel usually made for boiler plate, its characteristics, the causes of segregation, the essentials of good service, etc. 2500 w. Boiler Maker—April, 1912. No. 31857.

Tool Steel

Composition of High Speed Tool Steel. E. T. Edwards. Reports tests and gives records of performance of high speed steels. 3500 w. Ir Age—April 18, 1912. No. 32139 C.

Hints on the Working of Tool Steel. J. T. Towlson. Advice for inexperienced workers. 2500 w. Mech Wld—April 5, 1912. No. 31917 A.

Wire Rope

Calculations on the Strength of Wire Ropes (Note sur le Calcul du Travail du Metal dans les Cables Metalliques). Edgar Baticle. Mathematical discussion. 8000 w. Ann des Ponts et Chaussées—Jan.-Feb., 1912. No. 32076 E + F.

Wrought Iron

Wrought Iron. Herbert Pilkington. Abstract of paper read before the W. of Scotland Ir. & St. Inst. A comparison of wrought iron and basic mill steel on such subjects as corrosion, mechanical structure, strength, durability, etc. 3500 w. Ir & Coal Trds Rev—March 22, 1912. No. 31736 A.

MEASUREMENT

Air Measurement

Measuring Low-Pressure Air. G. S. Weymouth. Describes a method used in connection with treatment plants. 1500 w. Min & Sci Pr—April 20, 1912. No. 32363.

Dynamometers

The Dynamometer in Its Application to Railways (La Dynamomètre dans ses Applications aux Chemins de Fer). A. Huberti. A lecture on the principles and operation of dynamometers delivered before the Ecole Polytechnique. Diagrams. 7500 w. Alliance Industrielle—April, 1912. No. 32091 D.

Elasticity

The Theory of Elasticity (Teoria delle molle). V. Foschi. Mathematical discussion on elasticity derived by compression, bending, torsion, etc. Diagrams. Serial. 1st part. 10000 w. Ann della Soc d Ing e d Arch Ital—March 1, 1912. No. 32304 E.

Fluid Pressure

Strength of Steel Tubes, Pipes, and Cylinders Under Internal Fluid Pressure. Reid T. Stewart. Gives a comparison of the theoretical formulae for the strength of steel tubes, pipes, and cylinders under internal fluid pressure. 4000 w. Jour Am Soc of Mech Engrs—April, 1912. No. 31774 D.

Gas Metering

Flow of Gas Formulae, Derived, Analyzed, and Checked by Experimental Data, with Diagrams for Figuring the Flow of Gas in Street Mains and Services. J. M. Spitzglass. Read before the Illinois Gas Assn. Mathematical. 4500 w. Am Gas Lght Jour—April 22, 1912. Serial. 1st part. No. 32243.

Indicators

An Automatic Self-Contained Optical Load-Extension Indicator. W. E. Dalby. Shows an instrument, recently designed by the author, and a few load-extension diagrams of steel, copper, and iron obtained photographically. 1500 w. Mech Engr—April 12, 1912. No. 32264 A.

Laboratories

Foundry Laboratory Practice (Praxis im Giessereilaboratorium). Theo. Grzeschik. Presents views on sampling and analytic methods. Ills. Serial. 1st part. 1400 w. Giesserei-Zeit—March 15, 1912. No. 32000 D.

Pitometer

Saving \$2,000,000 Water Waste a Year. Herbert T. Wade. Illustrated description of the pitometer with an account of the results accomplished by its use. 1200 w. Sci Am—April 6, 1912. No. 31769.

Pressure Gauges

Meters for Pressure and Velocity of Gas and Steam (Messgeräte für Druck und Geschwindigkeit von Gasen und Dämpfen). H. Contzen. Brief description of several types of self-recording pressure gauges. Ills. 1400 w. Stahl u Eisen—April 4, 1912. No. 32017 D.

Pyrometers

High Temperature Measurement. Gives a classification and description of pyrometers as now used, discussing the condi-

tions to be satisfied, and the methods of using. Ills. 2000 w. Prac Engr—March 29, 1912. No. 31884 A.

Rivet Stresses

Stresses in Rivets of Standard Beam-Connection Angles. Jacob Friedland. Gives results brought out in recent investigations, with the method of arriving at them. 2200 w. Eng News—April 25, 1912. No. 32369.

Spirit Levels

The Testing of Spirit Levels. Detailed description of methods of testing in current use. Ills. 2200 w. Mach, N Y—April, 1912. No. 31673 C.

POWER AND TRANSMISSION**Bearings**

Making Babbitt and Babbitted Bearings. Jesse L. Jones. Illustrates and describes practice of the Westinghouse Elec. & Mfg. Co. 2800 w. Am Mach—April 18, 1912. No. 32117.

Compressed Air

The Use of Compressed Air in Boiler Shops. Thomas Aldcorn. Read before the Am. Boiler Mfrs' Assn. Discusses the production and storage of compressed air, its application, pneumatic tools and appliances. 5000 w. Ir Age—April 4, 1912. No. 31766 C.

Electric Power

Application of Electric Power in Wood-working Plants. H. O. Stewart. Discusses details of importance in such a plant. Ills. 5000 w. Elec Rev & W Elect'n—April 6, 1912. No. 31838.

Energy

Natural Sources of Energy. Gives reports received by the British Science Guild examining various sources of energy and means of economy. 8500 w. Col Guard—April 4, 1912. No. 31992 A.

Power Plant Tests

Report of Tests of Central Power Plant, Fort Winfield Scott, California. Capt. J. C. Johnson. 3000 w. Jour U S Art—March-April, 1912. No. 32152 N.

Rope Drive

The Transmission of Power by Cotton Ropes. R. E. Hart. From a paper read before the Assn. of Engrs.-in-Charge. Remarks on the ideals of a rope-drive, the difficulties and their solution, etc. 1600 w. Mech Wld—April 12, 1912. Serial. 1st part. No. 32269 A.

Turbo-Compressors

Turbo-Compressors in Practical Service. Considers the efficiency of turbo-compressors, the question of motor drive and the use of exhaust steam. Ills. 2200 w. Ir Age—April 4, 1912. No. 31762 C.

STEAM ENGINEERING**Accumulators**

Steam Regenerative Accumulators. D. B. Morison. Abstract of paper read before the Inst. of Engrs. & Shipbldrs. in Scotland. Illustrates and describes in detail the Rateau-Morison accumulator and its applications in British mines. 5000 w.

Ir & Coal Trds Rev—March 22, 1912. No. 31735 A.

Notes on Exhaust Steam Accumulators. Francis H. Davies. Describes several exhaust steam accumulators of English manufacture, and their performance. 1800 w. Power—April 23, 1912. No. 32245.

Boiler Cleaning

Notes on Cleaning Babcock and Wilcox Boilers. John S. Leese. Suggestions for the cleaning of these water-tube boilers. 1400 w. Elec Rev, Lond—March 29, 1912. No. 31877 A.

Boilers

A Needless Defect in the Modern Lancashire Boiler, Its Cause and Remedy. Sam. Boswell. Discusses the trouble with the front ends of high-pressure Lancashire boilers, which give trouble at the furnace mouths and gusset stay rivets in the form of leakage. Ills. 4500 w. Manchester Assn of Engrs—March 23, 1912. No. 31914 N.

Locomotive Boilers at Collieries. Explains some of the causes of explosions. Ills. 2500 w. Col Guard—April 12, 1912. No. 32270 A.

See also Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Specifications

Uniform Boiler Specifications. Recommendations by the committee of the Am. Boiler Mfrs. Assn. for changes in the Massachusetts boiler laws. 2500 w. Power—April 2, 1912. No. 31713.

Draft

Relative Economy of Various Types of Draft Equipment. T. F. J. Maguire. This third article of the series discusses forced mechanical draft. Ills. 3500 w. Engineering Magazine—May, 1912. No. 32342 B.

Engine Balancing

The Practical Side of the Balancing of Engines. Points out principles upon which the subject depends, avoiding mathematics and using the graphical treatment. 2500 w. Prac Engr—April 12, 1912. Serial. 1st part. No. 32259 A.

Engine Economy

Investigation of the Economy of a Simple Engine Operating with Steam Less Than That of Atmospheric Pressure. R. C. Carpenter. Gives results of an investigation tending to indicate that the reciprocating piston engine of small clearances can be operated with remarkable economy. Ills. 3000 w. Sib Jour of Engng—April, 1912. No. 32408 C.

Engines

Kerchove and Uniflow Steam Engines. Abstract translation of an article by Dr. Doederlein, in *Zeit. der Ver. deut. Ing.* Compares these two types. 2000 w. Power—April 16, 1912. No. 31974.

Flue Gas

Importance of the High Test of CO₂ in Boiler Flue Gases and Automatic Analysis and Record of Same. Abram T. Baldwin. Discusses problems of fuel waste, the im-

portance of analysis, the calorific value, combination, smoke prevention and related subjects. Ills. 6000 w. Jour Assn of Engng Soc—March, 1912. No. 31786 C.

Flue-Gas Explosions

Flue-Gas Explosions. Edw. Ingham. Describes some notable explosions, explaining the causes, and discusses means of avoiding them. 1800 w. Elec Rev, Lond—March 22, 1912. No. 31718 A.

Fuels

The Calorimetric Value of Fuel. John G. A. Rhodin. Considers the determining and expressing of calorific values. 4000 w. Engr, Lond—March 29, 1912. No. 31895 A.

Firing Soft Soal Screenings. John S. Leese. Notes from the writer's experience with hints on the manner of managing the fires. 1200 w. Mech Wld—April 5, 1912. No. 31916 A.

Heat Transmission

The Reduction in Temperature of Condensing Water Reservoirs Due to Cooling Effect of Air and Evaporation. W. B. Ruggles. Describes tests made to determine, if possible, a fairly reliable factor by the use of which the necessary size of a cooling reservoir for condensing water could be predetermined. Ills. 1000 w. Jour Am Soc of Mech Engrs—April, 1912. No. 31777 D.

The Heat Transmission of Hot Air in Tube Walls (*Die Wärmeübergang von heisser Luft an Rohrwandungen*). Heinrich Gröber. Mathematical discussion. 5400 w. Zeitschr des Ver deutscher Ing—March 16, 1912. No. 32040 D.

Indicator Diagrams

A New Analysis of the Cylinder Performance of Reciprocating Engines. J. Paul Clayton. Describes investigations showing that the indicator diagram contains the evidence necessary for an almost complete analysis of cylinder performance. Explains methods employed. 14000 w. Jour Am Soc of Mech Engrs—April, 1912. No. 31776 D.

Plant Management

Management of Steam Power Plants. Suggestions as to the maintenance and economical operation of steam plants. 1500 w. Power—April 23, 1912. No. 32246.

Smoke

See same heading, under CIVIL ENGINEERING, *Municipal*.

Thermodynamics

A Discussion of Certain Thermal Properties of Steam. G. A. Goodenough. The equation proposed by Linde is slightly modified and by means of the Clausius thermodynamic relation a formula for specific heat is derived, and other equations deduced. 4500 w. Jour Am Soc of Mech Engrs—April, 1912. No. 31773 D.

Turbine Designs

The Calculation of Steam Turbines under Specific Heads (*Die Berechnung der Dampfturbinen mit Hilfe des spezifischen*

Gefälles). Guido Zerkowitz. Mathematical discussion based upon the studies of Stodola and others. Diagrams. Serial. 1st part. 3600 w. Zeit f d ges Turbinenwesen—March 20, 1912. No. 32004 D.

Notes on the Predetermination of Steam Turbine Distributors and on the Question of Clearance Expansion (Beitrag zur Vorausberechnung von Leitvorrichtungen für Dampfturbinen und zur Frage der "Spaltexpansion"). Paul Christlein. Studies on inlet design. Ills. Serial. 1st part. 1500 w. Zeit f d Ges Turbinenwesen—April 10, 1912. No. 32318 D.

Turbines

New Developments in Steam Turbine Engineering. Edwin D. Dreyfus. A review of turbine development since 1884; types, etc. Ills. 5000 w. Elec Jour—April, 1912. Serial. 1st part. No. 32178.

The Kienast Steam Turbine. Illustrated description with results of tests. 1000 w. Power—April 9, 1912. No. 31853.

Ljungström Steam-Turbine. Illustrated detailed description of this radial-flow reaction turbine, its design and tests. Plates. 4500 w. Engng—April 12, 1912. Serial. 1st part. No. 32273 A.

Tests on a 1000 K.W. Exhaust Steam Turbine at the Neu-Iserlohn II. Mine of the Harpener Mining Co., Dortmund (Untersuchung einer Abdampfturbinenanlage von 1,000 K.W. auf der Zeche Neu-Iserlohn II. der Harpener Bergbau Akt.-Ges., Dortmund). Herr Schulte. Results of power tests. Ills. 3800 w. Zeitschr des Ver deutscher Ing—March 30, 1912. No. 32048 D.

See also same heading, under MARINE AND NAVAL ENGINEERING.

Turbine Testing

Arrangements and Test Results of the Turbine Laboratory at the German Science High School in Brünn (Einrichtung und Versuchsergebnisse des Turbinenlaboratoriums an der deutschen Technischen Hochschule in Brünn). Victor Kaplan. Account of some of the work at the laboratory with results. Ills. 5600 w. Zeit d Oest Ing u Arch Vereines—April 26, 1912. No. 32732 D.

Valves

Slide or Gate Valves (Schieber oder Ventil). Ernst Claassen. Discussion on the relative advantages of the two types in steam engine practice. Ills. 2700 w. Zeitschr des Ver deutscher Ing—March 23, 1912. No. 32045 D.

TRANSPORTING AND CONVEYING

Cableways

Extraordinary Cableways (Ungewöhnliche Drahtseilbahnen). Georg. von Hanffstengel. Description of some of the more noticeable cableways as found in various parts of the world. Ills. Serial. 1st part. 3800 w. Zeitschr des Ver deutscher Ing—April 20, 1912. No. 32722 D.

Car Dumping

A New Car Dumper (Ein neuer Wagenkipper). A new type of swing dumping

device, especially devised to unload cargoes. Ills. 2700 w. Zeitschr des Ver deutscher Ing—March 16, 1912. No. 32041 D.

Conveyors

Combined Ash and Coal Storage. W. O. Rogers. Illustrated description of plant at Wilkes-Barre, Pa., in which the coal and ash are handled by the same conveyor. 800 w. Power—April 30, 1912. No. 32436.

Cranes

Safety Appliances for Electric Driven Cranes and Hoists (Sicherheitsschaltung für elektrisch betriebene Krane und Hebezeuge). Herr Wintermeyer. Discusses electrically operated brakes and other safety devices. Ills. Serial. 1st part. 2200 w. Elektrotech Rundschau—March 21, 1912. No. 32062 D.

Elevators

Direct-Current Elevator Controllers. W. H. Patterson. Illustrates and describes types. 1000 w. Elec Jour—April, 1912. No. 32180.

Packing

Packing Lathes for Shipment. H. M. Wood. Considers the packing of machine tools to prevent damage in transit, describing methods. Ills. 1200 w. Am Mach—April 25, 1912. No. 32293.

Tractors

A Novel Light Steam Tractor. Illustrations and description of a tractor with air condenser and draught gear. 900 w. Sci Am Sup—April 20, 1912. No. 32175.

MISCELLANY

Congress

The 41st Congress for Delegates and Engineers at the International Convention of the Boiler Superintendents' Association (Die 41. Delegierten- und Ingenieur-Versammlung des Internationalen Verbandes der Dampfkessel-Ueberwachungs-Vereine). Abstracts from four pages on questions of boiler practice. 5800 w. Glückauf—March 23, 1912. No. 32030 D.

Flour Mills

Equipment of a Modern Flour Mill on a Gradual Reduction System. John F. Harrison and W. W. Nichols. An illustrated general outline of the process of milling by gradual reduction, with a review of progress in the mechanical construction of flour mills, and the process of manufacture. 5000 w. Jour Am Soc of Mech Engrs—April, 1912. No. 31775 D.

Tile Molding

Molding Cylinders with Outer Flanges or Wide-Flanged Pipes from Clay (Ueber das Formen von Zylindern mit äusseren Flanschen oder von grossen Flanschrohren in Lehm). W. Venator. Describes molding methods. Ills. 2000 w. Stahl u Eisen—April 1, 1912. No. 32020 D.

Vacuum Cleaners

Tests of Vacuum Cleaner Apparatus. M. S. Cooley. Gives comparative data on the performance of different types and suggests a method of acceptance test. 1800 w. Eng News—April 11, 1912. No. 31940.

Alaska

Matanuska Valley Coalfields, Alaska. G. C. Martin and F. J. Katz. Describes the coal and the mining conditions. 1500 w. Min & Sci Pr—April 6, 1912. No. 31924.

Belgium

Development of the Campine Coalfield. H. A. F. Stuckmann. Trans. from *Stahl und Eisen*. Information concerning this new coalfield in Belgium. 2500 w. Ir & Coal Trds Rev—March 29, 1912. No. 31901 A.

Coal Storage

A 600-Ton Coal Bin and Tower. Plans, elevation and description of a structure at Haselton, Ohio. 1200 w. Eng Rec—April 20, 1912. No. 32191.

Coking By-Products

The Manufacture of Benzol in Germany (La Fabrication du Benzol en Allemagne). Eng. Grandmougin. Description of several plants in Germany for the recovery of benzol from coke-oven gas. Ills. Serial. 1st part. 4200 w. Tech Mod—April 1, 1912. No. 32092 D.

Electric Power

The Lancashire Electric Power Company's System and Its Application to Lancashire Collieries. Abstract of paper by Charles D. Taite, with discussion before the Manchester Geol. & Min. Soc. Detailed description. 5000 w. Col Guard—March 22, 1912. No. 31727 A.

A New Method of Electric Winding at the Auchincruive Pits of Messrs. William Baird & Co. Illustrated description of an electrical coal-winding plant recently put into operation in Scotland. 2000 w. Ir & Coal Trds Rev—April 5, 1912. No. 32106 A.

Explosions

Overcasts with Light Walls. A. A. Steel. Illustrates and describes a method of construction that will afford relief for explosive pressure and can be readily repaired. 1000 w. Mines & Min—April, 1912. No. 31737 C.

See also Boilers, under MECHANICAL ENGINEERING, *Steam Engineering*.

Gas Detection

The Use of Mice and Birds for Detecting Carbon Monoxide after Mine Fires and Explosions. George A. Burrell. A report of experimental investigations of methods that can be used with safety in exploring mines containing smoke or gases. 5500 w. U. S. Bureau of Mines—Tech. paper 11. No. 32453 N.

Germany

The Stratifications in the Witten Basin between Heven and Stiepel (Die Lagerungs- und Flözverhältnisse in der Wittener Hauptmulde zwischen Heven und Stiepel). Oberste-Brink. Discusses peculiarities of geological formation. Diagrams. 3500 w. Glückauf—March 30, 1912. No. 32031 D.

India

The Coal Industry of India. Brief review of its development and causes affect-

ing it. 1500 w. Col Guard—April 12, 1912. No. 32271 A.

Peat

Peat in Agriculture. Paul H. Todd. Considers operations on which the cultivation of peat-lands depend. 3500 w. Jour Am Peat Soc—Jan., 1912. No. 32351 H.

The Recent Development of Peat as a Power Factor. T. A. Mighill. Reviews what has been accomplished in the use of peat for power purposes. 3000 w. Jour Am Peat Soc—Jan., 1912. No. 32350 H.

Peat Machine

Dr. Willandt's Peat Machine. Illustrated description of an automatic peat digging machine. 1400 w. Jour Am Peat Soc—Jan., 1912. No. 32349 H.

Planes

A New Type of Gravity Plane. J. J. Smith. Describes types of self-acting planes, explaining details of a double-track incline and its operation. Ills. 7500 w. Eng & Min Jour—April 13, 1912. No. 31960.

Winding Engines of the Ashley Planes. Warren O. Rogers. Illustrated description of the new engines which haul freight cars up three planes near Wilkes-Barre, Pa., and of the planes. 1500 w. Power—April 2, 1912. No. 31708.

Rescue Methods

Lessons from Recent Mine Disasters. From an address by Dr. Joseph A. Holmes at Knoxville, Tenn. Considers precautions against fires and explosions, and the importance of trained rescue men. 4500 w. Mines & Min—April, 1912. No. 31739 C.

COPPER

Calumet & Hecla

See Deep Mining, under *Mining*.

Concentration

Miami Concentrating Mill. C. E. Golding. Illustrated description of a successful mill in Arizona, of 4,000 tons daily capacity, working the low-grade copper ore. 2500 w. Mines & Min—April, 1912. No. 31741 C.

Extraction Methods

Copper and Its Alloys in Early Times. Prof. William Gowland. Abridged from the Presidential address to the Inst. of Metals. A description of primitive methods of extraction and metal working. Ills. 6000 w. Nature—March 28, 1912. No. 31872 A.

Mining Methods

Baltic Method of Mining. Claude T. Rice. Illustrated account of the method of mining used at the Baltic copper mine in Michigan. 6000 w. Eng & Min Jour—April 27, 1912. Serial. 1st part. No. 32398.

New Mexico

Milling the Ore of the Chino Mine. John M. Sully. Describes the power plant and buildings of this copper mine, and the milling methods which it employs. Ills. 2200 w. Min & Sci Pr—March 30, 1912. No. 31809.

Sampling

The Mathematics of Copper Sampling. Edward Keller. Discusses the interior structure of copper bars, and explains a method of sampling by which each separate hole can be made to represent the average of the bar in which it is placed. 2500 w. Eng & Min Jour—April 6, 1912. No. 31828.

GOLD AND SILVER**Cyanide Records**

Cyanide Mill Metallurgical Records. E. H. Webster. Gives forms for recording the data, and suggestions as to methods of obtaining the information. 2500 w. Eng & Min Jour—April 20, 1912. No. 32223.

Cyaniding

Cyaniding of Concentrate. E. M. Hamilton. Discusses aspects of the subject drawn from the experience of the writer. 5000 w. Eng & Min Jour—April 27, 1912. No. 32397.

See also Precipitation, under *Gold and Silver*.

Dredging

Examination of Dredging Properties. Francis J. Dennis. Considers factors necessary to ascertain in determining the value of placer-ground. 1500 w. Bul Am Inst of Min Engrs—April, 1912. No. 32416 F.

Elevating Ten-Cent Gravel at a Profit. C. S. Haley. Illustrates and describes an elevating system in use in California for handling low-grade, poor dump bars of rivers and similar problems. 4000 w. Min & Sci Pr—April 13, 1912. No. 32168.

Gold Dredging in the River Coxipómirim, Matto Grosso, Brazil. Luiz Caetano Ferraz. Describes the work and the dredges used. 1800 w. Min Jour—March 30, 1912. No. 31883 A.

Mexico

The Influence of Smelting, Electricity and the Cyanide Process on Mexican Silver Mining. Victor M. Braschi. From the *Bul. of the Mex. Inst. of Min. & Met.* A report of satisfactory results. 2000 w. Can Min Jour—April 15, 1912. No. 32208.

The Mines of the Sonora Valley, Sonora, Mexico. Claud Hafer. Brief illustrated description of the mining properties. 2500 w. Min & Engng Wld—April 27, 1912. No. 32445.

Precipitation

Zinc Dust Tests. W. J. Sharwood. Report of tests to determine its value for precipitating purposes in a cyanide plant. Ills. 5000 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1912. No. 31982 E.

Tennessee

The Coker Creek Gold Field. Describes some low-grade deposits in Tennessee. 2500 w. Mines & Min—April, 1912. No. 31742 C.

IRON AND STEEL**Analysis**

Reduction and Carburation in Blast-Furnaces, Exemplified in Connection with

Blast-Furnace Interruptions and in the Light of Smelting Tests (Reduktion und Kohlung im Hochofen, im Zusammenhange mit Hochofenstörungen und auf Grund von Schmelzversuchen erläutert). B. Osann. A metallurgical discussion. Ills. Serial. 1st part. 4900 w. Stahl u Eisen—March 21, 1912. No. 32009 D.

Blast-Furnace Air

Advantages, Disadvantages and Cost of Combining Oxygen with the Draft in Blast-Furnaces (Vorteile, Nachteile und Kosten der zumischung von Sauerstoff zum Gebläsewinde der Hochofen). Fr. W. Lürmann. General remarks on this practice. 1400 w. Stahl u Eisen—April 11, 1912. No. 32315 D.

Blast-Furnace Practice

Experiments With the Thiogen Process. Frank L. Wilson. Condensed from an address by S. W. Young, giving a detailed account of the process and the results obtained. 1500 w. Min & Sci Pr—April 6, 1912. No. 31923.

Blast Furnaces

Automatic Blast Furnace Charging. David Baker. Illustrated description of a mechanical controller and its operation. 1500 w. Ir Age—April 4, 1912. No. 31761 C.

A New Thin-Lined Blast Furnace. Illustrated description of a type of furnace adapted to existing stacks, and the cooling system. 2000 w. Ir Age—April 18, 1912. No. 32141 C.

Blast Furnaces of the Rogers-Brown Iron Co. Illustrated description of two new stacks, Nos. 3 and 4, added to the Susquehanna plant, at Buffalo. 2500 w. Ir Trd Rev—April 11, 1912. No. 31927.

Blast-Furnace Slag

See Cement, under **CIVIL ENGINEERING**, *Materials of Construction*.

Charcoal Iron

Charcoal Iron by a New Process. Describes a new process invented by J. Jones Hudson, which consists in smelting the charge between layers of charcoal in a specially designed furnace of the open hearth type. Ills. 1000 w. Ir Age—April 18, 1912. No. 32140 C.

Dry Blast

The New Dry Blast at Standish, N. Y. John B. Miles. Illustrated description of the plant of the Northern Iron Co., extracting moisture from the air after compression by sprays of water and sprays of brine. 1200 w. Ir Age—April 25, 1912. No. 32331 C.

Electric Power

Electrification of a Reversing Mill of the Algona Steel Co. Bradley T. McCormick. Illustrated detailed description of an electric reversing mill equipment at Sault Ste. Marie, Can. 2000 w. Pro Am Inst of Elec Engrs—April, 1912. No. 32422 F.

Electro-Metallurgy

Experiments in Electrical Smelting of Iron Ores. S. Rice. Information con-

cerning this new process. Ills. 4000 w. Min & Engng Wld—April 13, 1912. No. 31972.

Electric Furnace Production of Pig Iron and Pig Steel. Joseph W. Richards. Deals with the technical side of the process of the reduction of iron ores in an electrically heated furnace. Discussion. Ills. 8000 w. Pro Engrs' Soc of W Penn—March, 1912. No. 32122 D.

The Production of Cast Iron in Electric Furnaces in Sweden (La Production de la Fonte au Four Électrique en Suède). Paul Nicou. A description of the Trollhättan plant and report of its results. Ills. 2500 w. Rev de Metall—April, 1912. No. 32088 H.

Ferro-Alloys

Melting Ferro-Manganese in the Electric Furnace (Ueber das Umschmelzen von Ferromangan im elektrischen Ofen). R. Korten. Paper read before the German Metallurgical Association on operation with the Keller furnace. Discussion. 5000 w. Stahl u Eisen—March 14, 1912. No. 32006 D.

Ingots

The Production of Small Ingots in Quantity. G. Marton in *Stahl und Eisen*. Illustrated description of an ingot stripping and handling plant by which the whole battery of ingot moulds is stripped at once, without manual labor. 700 w. Ir & Coal Trds Rev—April 5, 1912. No. 32105 A.

Metallography

Apparatus for Metallography. Carle R. Hayward. Illustrated description of a grinding and polishing machine for preparing specimens of metals for microscopic examination. 800 w. Ir & Coal Trds Rev—April 5, 1912. No. 32104 A.

Metallurgy

Notes on Metallurgy in 1911 (Mitteilungen über die Metallforschung in Jahre 1911). H. Winter. Reviews some of the metallurgical investigations made during the past year. 2400 w. Glückauf—March 23, 1912. No. 32029 D.

Prices

The Control of Prices in the Export Steel Trade. Harold Jeans. Read before the Staffordshire Iron & Steel Inst. Discusses the international position as affected by the Conference held in Brussels. 7500 w. Ir & Coal Trds Rev—March 29, 1912. No. 31904 A.

Pyrites

Commercial Pyrites; Its Sources, Grades and Uses. W. C. Dumas. Abstract of paper read before the Georgia section of the Am. Chem. Soc. Information concerning the world's deposits, the production and uses. 2000 w. Min & Engng Wld—April 13, 1912. No. 31971.

Re-rolling Mill

A Large Re-rolling Mill of Unusual Design. Illustrated detailed description of the Laclede Steel Co.'s new mill for re-

rolling rails and billets. 2500 w. Ir Trd Rev—April 4, 1912. No. 31789.

Rolling Mills

A Notable Example of British Practice in Rolling Mill Electrification. G. M. Brown. Describes the electrical equipment of a 28-in. cogging mill at Middlesbrough, England. Ills. 2500 w. Gen Elec Rev—April, 1912. No. 31863 C.

Smelting

Air in Pyritic Smelting. E. W. Walter. States facts determined by experience in pyritic smelting. 1800 w. Eng & Min Jour—April 20, 1912. No. 32224.

Steel Works

The Tata Iron & Steel Company's Plant. Illustrated detailed description of the blast furnaces and steel works built in India. Plate. 2500 w. Ir Age—April 11, 1912. No. 31930 C.

Sweden

The Enrichment of Iron Ore in Sweden (Anreicherung der Eisenerze in Schweden). R. Lämmert. Review of practice in this country. Ills. and Diagrams. 4000 w. Stahl u Eisen—April 4, 1912. No. 32018 D.

LEAD AND ZINC

Lead Smelting

Method for Utilization of Lead-Furnace Fumes. L. S. Hughes. From *Jour. Ind. & Engng-Chem.* An account of its conversion into lead hydrate and the possibilities of the new process. 2000 w. Min & Engng Wld—April 27, 1912. No. 32444.

Precipitation

The Estimation of Lead, Nickel, and Zinc by Precipitation as Oxalates and Titration with Potassium Permanganate. H. L. Ward. Reports results of experimental investigations. 1200 w. Am Jour of Sci—April, 1912. No. 31778 D.

Zinc Smelting

Zinc Smelting in Kansas and Oklahoma. Gives the works in operation in the natural-gas fields with brief descriptions of their equipment and practice. 3000 w. Eng & Min Jour—April 27, 1912. No. 32399.

MINING

Caving System

Caving System at Ohio Copper Mine. Clarence C. Bamberger. Describes this system of mining showing that the cost compares favorably with steam-shovel methods. 1500 w. Eng & Min Jour—April 6, 1912. No. 31827.

Deep Mining

Copper Mining in America at Great Depths. Alexander Paterson. Read before the W. Branch of the Scottish Fed. Inst. of Min. Students in the Roy. Tech. College, Glasgow. Detailed description of methods of the Calumet & Hecla Mining Co. Diagrams. 3500 w. Ir & Coal Trds Rev—March 29, 1912. No. 31900 A.

Diamond Drilling

Speeds and Cost of Diamond Drilling at Porcupine, Canada. Albert E. Hall.

Brief report. 800 w. Sch of Mines Qr—April, 1912. No. 32158 D.

Diamond Drill Results at Pearl Lake, Porcupine, Ontario. G. W. Thomson. Describes the ore, the structural conditions, sampling, method of averaging and related matters. 2000 w. Can Min Jour—April 1, 1912. No. 31768.

Recent Practice in Diamond Drilling and Borehole Surveying. John I. Hoffman. Describes recent improvements in the drilling and surveying of boreholes. Ills. 4000 w. Inst of Min & Met, Bul 91—April 11, 1912. No. 32338 N.

Drills

Fixtures and Gages for Rock Drills. Fred H. Colvin. Gaging methods that secure good results are shown, and drilling fixtures used. Ills. 1500 w. Am Mach—April 11, 1912. No. 31860.

Drilling Machines for Mining Plants (Bohrmaschinenelle Bergbaubetriebe). L. Henker. Discusses various types of drills with particular attention to longitudinal machines. Ills. Serial. 1st part. 2000 w. Oest Zeit f Berg u Huttenwesen—March 9, 1912. No. 32014 D.

Electric Power

The Operation of Electrical Apparatus in Mines by Remote Control. Jas. Gillespie. Read before the Assn. of Min. Elec. Engrs. Calls attention to the possibilities and advantages of remote control. 2500 w. Ir & Coal Trds Rev—April 12, 1912. No. 32288 A.

Laws

Birth of the American Mining Act. H. W. MacFarren. Explains the conditions under which was passed the first mining act of 1866 relating to lode claims, the second act of 1870 relating to placer claims, and the third and final act of 1872 superseding the acts of 1866 and 1870. Serial. 1st part. 5500 w. Min & Sci Pr—April 13, 1912. No. 32167.

Methods

Methods Used in Mining Underground Wide Lodes or Masses. J. Bowie Wilson. General description of the caving system, the rill system, the shrinkage system, and flat back slice and fill system. 4500 w. Aust Min Stand—Feb. 29, 1912. Serial. 1st part. No. 31808 B.

Mining Practice in Pioneer District of Iron Range. Reviews the section in Wisconsin and the lessons to be learned from this iron-mining district. Ills. 2000 w. Min & Engng Wld—April 27, 1912. No. 32446.

The Hancock Con. Mine, Mich., and Its Equipment. Warren Aikens. Illustrated account of this copper mine and the methods of operation employed in it. 1700 w. Min & Engng Wld—April 13, 1912. No. 31970.

The Quincy Mine, Mich., from Stope to Smelter. George E. Edwards. Illustrated description of one of the oldest copper properties and its economical methods.

2000 w. Min & Engng Wld—April 20, 1912. No. 32238.

Brown Hematite Mining in Virginia. Charlton Dixon. Illustrates and describes the sub-level and carrying system of mining. 1500 w. Mines & Min—April, 1912. No. 31744 C.

Mine Locomotives

Operating Features of Mine Locomotives. G. W. Hamilton. Illustrates and describes electric locomotives for this service, and discusses the conditions of service. 1200 w. Elec Jour—April, 1912. No. 32182.

Comparative Tests on Mine Locomotives (Vergleichende Untersuchungen an Grubenlokomotiven). Herrn. Bütow and Dobbelstein. The first instalment treats of locomotives operated by compressed air. Ills. Serial. 1st part. 2800 w. Glückauf—March 23, 1912. No. 32028 D.

Mine Reports

Our Big Mines. An examination of their balance sheets by a mining accountant. 800 w. Aust Min Stand—Feb. 29, 1912. Serial. 1st part. No. 31807 B.

Ore Deposits

The Laws of Igneous Emanation Pressure. Blainey Stevens. Considers the various pressures of emanation and their mechanical causes and effects, deducing a classification. Ills. 3000 w. Bul Am Inst of Min Engrs—April, 1912. No. 32417 F.

Physical Data of Igneous Emanation. Blainey Stevens. Considers the general physical states in which aqueous emanations may occur, the possible conditions under which mineral elements may occur in emanations, proposing classification, and outlining investigation urged. 3000 w. Bul Am Inst of Min Engrs—April, 1912. No. 32418.

Gels in Ore Deposition. E. Hatschek and A. L. Simon. Report of investigations. Ills. 3500 w. Inst of Min & Met, Bul 91—April 11, 1912. No. 32337 N.

Decrease of Values in Ore. Shoots with Depth. Reginald E. Hore. Discusses deposits in Michigan and Ontario, recently studied. The copper mines in Houghton Co., Mich., and the Porcupine and Cobalt deposits. 3500 w. Can Min Jour—April 15, 1912. No. 32206.

Safety Precautions

Safety Precautions for Underground Workers in Mines (Die Versicherungspflicht der Unternehmerarbeiter auf Bergwerken). Herr Eschenbruch. Review of German inspection laws. 7000 w. Glückauf—March 16, 1912. No. 32027 D.

Shafts

Vertical vs. Incline Shafts in Metal Mining. John Malcolm Nicol. Abstract from *Trans. of Mex. Inst. of Mines & Met.* Examines the shafts sunk in precious metal mining under four heads. 3000 w. Min & Engng Wld—March 30, 1912. No. 31688.

Shaft Sinking

Cement Grout and Compressed Air in Shaft Sinking. R. C. Johnson, in *Coal Age*. Description of methods and operations. Ills. 2500 w. Compressed Air—April, 1912. No. 31921.

The Process and Cost of Shaft Sinking by the Freezing Process (Leistungen und Kosten beim Schachtabteufen nach dem Gefrierverfahren). Prof. Stegemann. Some figures obtained from mines adopting this method. 7200 w. Glückauf—March 16, 1912. No. 32026 D.

Surveying

Mine-Survey Notes. Discussion of the paper of George W. Riter. 2200 w. Bul Am Inst of Min Engrs—April, 1912. No. 32421 F.

Some Practical Points Regarding Mine Surveying. H. G. Henderson. Explains a simple method of leveling, and describes some miners' instruments and their use. 1000 w. Ir & Coal Trds Rev—March 29, 1912. No. 31902 A.

Timbering

The Economic Aspects of Steel Mine Timbers. R. B. Woodworth. Illustrated discussion of the advantages and disadvantages of the steel forms used. 3500 w. Min & Engng Wld—March 30, 1912. No. 31691.

Winding

The Whiting System of Hoisting Winding. Walter Heys. From *Science & Art of Mining*. Describes arrangements for a very deep mine. 1800 w. Min & Engng Wld—April 27, 1912. No. 32447.

Prevention of Overwinding with Special Reference to the "Visor" Controller. J. Strachan. Read before the Nat. Assn. of Col. Mgrs. Discusses the subject generally, and gives an illustrated description of the "Visor" controller. 3000 w. Ir & Coal Trds Rev—April 12, 1912. No. 32287 A.

See also Electric Power, and Planes, under *Coal and Coke*.

MINOR MINERALS**Aluminum**

See also Separation, under *Ore Dressing and Concentration*.

Cement

See same heading, under *CIVIL ENGINEERING, Materials of Construction*.

Oil-Fields

Present Conditions in the California Oil-Fields. Mark L. Requa. A review of this field, its production, value, and related topics. 3500 w. Bul Am Inst of Min Engrs—April, 1912. No. 32414 F.

The Maikop Oilfield. E. H. Cunningham Craig. Aims to give known facts about the field, and to indicate to what the facts point toward its future development. 2200 w. Min Jour—March 30, 1912. No. 31882 A.

Oil-Shale

Oil-Shale Industry. Extracts from report on fifty tons of the material, sent to

Scotland for testing. 2000 w. Can Engr—April 18, 1912. No. 32229.

Potash

Potash Deposits in America. Guy Elliott Mitchell. Discusses the possibilities of overcoming the German monopoly. Ills. and Maps. 4500 w. Cassier's Mag—April, 1912. No. 31831 B.

Tinstone

Occurrence of Tinstone in the Burnett District. Lionel C. Ball. Illustrated description of this tin-bearing area in Queensland, and its development. 4500 w. Queens Gov Min Jour—March 15, 1912. No. 32289 B.

ORE DRESSING AND CONCENTRATION**Concentration**

Re-treatment of Table Middlings. Gelasio Caetani. Considers a method of concentration by classification. 1200 w. Min & Sci Pr—April 6, 1912. No. 31922.

Concentration Analysis from Cananea Practice. Alfred Tellam. The figures given are taken from the practice of the plant at Sonora, Mexico. Flow sheet and map. 3500 w. Min Mag—April, 1912. No. 32429 B.

Filtration

Some Recent Improvements in Filtration Methods. Ernest J. Sweetland. Abstract of a paper before the Am. Chem. Soc. Illustrated description of the author's filter press for the cyanide process. 2500 w. Min & Engng Wld—April 20, 1912. No. 32240.

Flotation Process

Tests on the Leuschner Flotation Process at the Friedrichsseggen Mine (Das Schwimmaufbereitungsverfahren der Grube Friedrichsseggen nach System Leuschner). Herr Holtmann. Describes this process and tabulates some results obtained by these tests. Ills. 2800 w. Glückauf—March 9, 1912. No. 32025 D.

Fume Losses

Mineral Losses in Gases and Fume. F. G. Cottrell. Abstract from *Jour. of Ind. Engng. & Chem.* Considers mineral wastes passing out of the stacks of smelters and metal refineries. Also editorial. 3200 w. Min & Sci Pr—March 30, 1912. No. 31810.

Gold Milling

Colburn-Ajax Mill, Victor, Colorado. S. A. Worcester. Illustrates and describes features of a mill using the Moore-Clancy process. 2500 w. Eng & Min Jour—April 13, 1912. No. 31961.

Milling Practice

Heavy Stamps Find Favor at Nevada Mines. A. H. Martin. Illustrated description of the latest development in milling practice. 1800 w. Min & Engng Wld—March 30, 1912. No. 31689.

Precipitation

The Electrical Precipitation of Suspended Particles. F. G. Cottrell. Illustrates and describes processes for the removal of suspended particles from gasses by electrical appliances. 3000 w. Cement

& Engng News—April, 1912. Serial. 1st part. No. 31956.

See also same headings, under *Gold and Silver*, and *Lead and Zinc*.

Separation

Some Methods of Separating Aluminum from Iron. Gordon Surr. Considers practical aspects of methods in which the aluminum and iron are first precipitated as hydrates by ammonia. 2500 w. Min & Engng Wld—April 27, 1912. No. 32448.

Slimes

Air-Lifting of Slime-Pulp. A. W. Allen. Detailed description of the method. Ills. 1800 w. Min Mag—April, 1912. No. 32432 B.

The Parral-Tank System of Slime Agitation. Bernard Macdonald. Reviews various systems of agitation, noting their defects, and gives an illustrated description of the Parral-Tank system explaining its advantages. 5000 w. Bul Am Inst of Min Engrs—April, 1912. No. 32415 F.

Solutions

Electrolytic Dissociation and Solvation. Harry C. Jones. Discusses theories of solutions. 5500 w. Eng & Min Jour—March 30, 1912. No. 31679.

Solution and Its Importance. Harry C. Jones. Considers nine varieties of solution, and functions. 6000 w. Eng & Min Jour—April 6, 1912. No. 31826.

Further Studies in Solution. Harry C. Jones. The relation of diffusion and osmotic pressure, hydrolytic and electrolytic dissociation, precipitation, etc., are considered. 7000 w. Eng & Min Jour—April 20, 1912. No. 32225.

Stamp Foundations

Reinforced Concrete for Stamp Foundations. J. P. Fuller. Notes relating to a 40-stamp mill built in Sumatra. 1000 w. Min Mag—April, 1912. No. 32430 B.

RARE MINERALS

Diamonds

New Diamond Field Near Bloemhof, Transvaal. Information concerning this recent discovery. 1800 w. Min & Engng Wld—April 6, 1912. No. 31836.

Platinum

The Direct Determination of Small Amounts of Platinum in Ores and Bullion. Frederick P. Dewey. Gives a method of precipitation from a solution by adding hydrogen sulphide in the presence of silver. 1500 w. Bul Am Inst of Min Engrs—April, 1912. No. 32419 F.

Platinum (Ueber Platin). E. Prioznik. Review of the general physical and chemical characteristics of platinum. Serial. 1st part. 2800 w. Oest Zeit f Berg u Hüttenwesen—March 16, 1912. No. 32015 D.

MISCELLANY

Alaska

Alaska. A Much Misunderstood Territory. Frank P. McKibben. A practical

proposal for constructive conservation. Ills. 1500 w. Engineering Magazine—May, 1912. No. 32347 B.

See also same heading, under *Coal and Coke*; and *Yukon*, under *Miscellany*.

Canada

Gowganda During 1911. G. M. Colvocoresses. Review of the work of the year, and indefinite remarks on the future prospects. Ills. 2500 w. Can Min Jour—April 15, 1912. No. 32205.

Honduras

Mineral Resources of Honduras, Central America. A. D. Akin. Information concerning the mineral riches. 3000 w. Min & Engng Wld—April 20, 1912. No. 32241.

Idaho

Mines and Mills of Shoshone County, Idaho. Robert N. Bell. Information abstracted from the last annual report concerning the different properties. 3000 w. Min & Engng Wld—April 6, 1912. No. 31829.

Joplin

Following the Ore in Joplin Mines. Lucius L. Wittich. Illustrates and describes the methods employed in the sheet ground, the disseminated ore, and the soft ground. 3500 w. Mines & Min—April, 1912. No. 31745 C.

Land Slides

Effects of Land Slides in Mining Regions. Arthur Lakes. Illustrates and describes some of the effects. 2000 w. Min & Engng Wld—April 20, 1912. No. 32239.

Macedonia

Mines and Minerals of Macedonia. John L. Binda. Brief account of native methods and description of the principal mines. Manganese, iron, pyrite and other minerals. Ills. 1500 w. Min & Sci Pr—April 13, 1912. No. 32169.

Mine Caves

Mine-Caves Under the City of Scranton. Short discussion of the paper of Eli T. Connor. 1000 w. Bul Am Inst of Min Engrs—April, 1912. No. 32420 F.

Ontario

A Visit to Porcupine. W. R. Ingalls. An account of the development at the Hollinger and Dome mines, the mills under construction, and the district generally. Plans. 2000 w. Eng & Min Jour—March 30, 1912. No. 31677.

Yukon

Conditions in the Yukon. Guy A. R. Lewington. Explains conditions in the Klondike district of Yukon territory of Canada, showing their superiority to Alaska, and describing the climate. 1000 w. Min Mag—April, 1912. No. 32431 B.

Present Outlook and Conditions in the Klondike Region. Arthur Lakes, Jr. An account of this region of the Yukon, B. C. 1500 w. Min & Engng Wld—April 27, 1912. No. 32449.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Accident Costs

The Cost of Workmen's Compensation to the Railways. Condensed tabulations made by Edward Bunnell Phelps on the probable cost to the community and to various industries. 1500 w. Ry Age Gaz—April 19, 1912. No. 32218.

Dispatching

The Use of the Telephone in Railroad Service. G. K. Heyer. Outlines briefly the history of train dispatching, giving in detail the results of using the telephone in this field, illustrating and describing instruments and methods. Discussion. 6500 w. Pro Ry Club of Pittsburgh—Feb. 23, 1912. No. 32149 C.

Signalling

Electrical Locomotive Cab. Signalling. Illustrates and describes improvements introduced in the system designed by Vincent L. Raven. 1200 w. Engr, Lond—March 29, 1912. No. 31898 A.

The Block Signal Board's Inspection Reports. Editorial in *The Signal Engineer* for April. A critical review. 2200 w. Ry Age Gaz—April 19, 1912. No. 32216.

Carson-Burgess Cab Signal and Automatic Train Stop. Illustrated description of an electro-automatic signal that shows whether the track is occupied for two blocks ahead or in the rear, and a train stop automatically applies the brakes. 2000 w. Ry & Engng Rev—March 30, 1912. No. 31714.

Safety Appliances on the Mariazeller Railway (Die Sicherungsanlagen auf der Mariazeller Bahn). Robert Kratochwil. Presents description of some unusual conditions to be met by this short spur crossing the main line. Ills. 2400 w. Zeit d Oest Ing u Arch Ver—March 29, 1912. No. 32056 D.

Trains

Corridor Trains; London, Tilbury, and Southend Railway. Plate, and illustrated description of trains for special service. 1200 w. Engng—March 29, 1912. No. 31890 A.

MOTIVE POWER AND EQUIPMENT

Air Brakes

Leakage in L. T. Equipment. Suggestions for repair work. 1800 w. Ry & Loc Engng—April, 1912. No. 31748 C.

Air Pumps

Air Pump Efficiency. Explains the difference between efficiency and capacity. 2500 w. Ry & Loc Engng—April, 1912. No. 31749 C.

Brakeshoes

Some Tests of Brakeshoes. George L. Fowler. Report of four types tested to

learn their relative efficiency and cost. 6000 w. Elec Ry Jour—April 6, 1912. No. 31844.

Car Cleaning

Compressed-Air Cleaning on Railways. H. Jacobi. Critical comments on the faults of vacuum cleaners, with illustrated description of the process named. 2700 w. Bul Int Ry Cong—April, 1912. No. 32357 G.

Cars

New Steel Cars for the New York, Westchester & Boston Railway. Illustrates and describes interesting constructional features. 3500 w. Elec Ry Jour—March 30, 1912. No. 31684.

Car Wheels

Control of Mixtures for Cast Iron Car Wheels. Asa W. Whitney. Discusses the advantages of the microscope in car wheel practice and remarkable examples of cast iron chill. Ills. 2500 w. Foundry—April, 1912. No. 31697.

Steel Wheels. C. G. Bacon, Jr. A discussion of standard designs and specifications, considering 21 designs, and urging the reduction to 11, giving reasons. General discussion. Ills. 12000 w. Pro W Ry Club—Feb. 20, 1912. No. 31779 C.

Freight Cars

Defective Box Cars and Damaged Freight. Information concerning the extent of loss for which condition of equipment is responsible and how it may be reduced. Ills. 2500 w. Ry Age Gaz—April 12, 1912. Serial. 1st part. No. 31942.

Inspection Cars

Vehicles for Permanent Way Inspection. Dr. H. Saller. Illustrates and describes vehicles used in Sweden, and discusses the qualities required, and the need of this assistance for watchman. 2000 w. Bul Int Ry Cong—April, 1912. No. 32358 G.

Locomotive Boilers

The Laws of Evaporation and Heat Transmission in Locomotive Boilers (Ueber das Verdampfungsgesetz und das Gesetz der Wärmeübertragung des Lokomotivkessels). O. Köchy. Mathematical review of various determinations of these laws. Diagrams. 5500 w. Zeitschr des Ver deutscher Ing—March 30, 1912. No. 32049 D.

The Damage to Tubular Plates in Locomotive Boilers (Les Avaries des Plaques Tubulaires dans les Chaudières de Locomotives). H. Lavialle d'Anglards. Notes on the repair of tubular boiler plates and methods of repair. Ills. Serial. 1st part. 2400 w. Génie Civil—March 9, 1912. No. 32096 D.

Locomotive Maintenance

Locomotive Maintenance Costs. Gives a table of expenses of 30 large railways for the maintenance of locomotives during the past four years. Also an article on the "Weight of Equipment as a Factor in the Cost of Transportation." 2500 w. Ry & Engng Rev—April 6, 1912. No. 31851.

Locomotive Performance

Mallet Results in Road Service. Reports 37½ per cent saving effected by the use of high capacity freight locomotives on the C. & O. Ills. 2000 w. Ry Age Gaz—April 5, 1912. No. 31803.

Locomotives

British Locomotives in 1911. Thomas Reece. Illustrates and describes four typical locomotives. 2500 w. Ry Mas Mech—April, 1912. No. 32110.

British Locomotives in 1911. J. F. Gairns. Review of new designs and work. Ills. 7000 w. Bul Int Ry Cong—April, 1912. No. 32355 G.

Locomotives for the Caledonian Railway Fitted for Burning Oil. J. F. McIntosh. Gives the piping arrangement of a temporary installation employing the Holden liquid-fuel injectors. 200 w. Engng—April 12, 1912. No. 32275 A.

Some Recent French Locomotives. Illustrates and describes new types. 400 w. Engr, Lond—April 12, 1912. No. 32284 A.

Santa Fe Type Locomotive for the Chicago, Burlington & Quincy R. R. Illustrated detailed description of engines of the 2-10-2 type for freight service. 2000 w. Ry & Engng Rev—April 13, 1912. No. 31981.

Consolidation Locomotive, Leopoldina Railway. Illustrated description of a powerful 2-8-0 locomotive for Brazil. 500 w. Ry Gaz, Lond—April 12, 1912. No. 32257 A.

Standard (4-4-0 Type) Locomotive; Eastern Bengal State Railway. Illustrated description. Plate. 700 w. Engng—April 5, 1912. No. 31996 A.

Mallet Locomotives in Road Service on the Chesapeake & Ohio Ry. Illustrations of the Mallet compound and the consolidation formerly in service, with description and report of savings claimed by the change. 2000 w. Ry & Engng Rev—April 27, 1912. No. 32450.

1-C-1 Express Locomotives (1-C-1-Schnellzuglokomotive). Herr Michin. Detailed description of Russian passenger express locomotive. Ills. and plate. 3300 w. Zeitschr des Ver deutscher Ing—Mar. 30, 1912. No. 32046 D.

Recent Types of Steam and Electric Locomotives (Quelques récentes locomotives à vapeur et électriques). M. de Valbreuze. Modern European and American types presented. Ills. 6000 w. Bull Soc Int d'Électriciens—March, 1912. No. 32084 F.

See also Stresses, under CIVIL ENGINEERING, *Bridges*; Mine Locomotives, under MINING AND METALLURGY, *Mining*, and Locomotives, under STREET AND ELECTRIC RAILWAYS.

Locomotive Superheating

The Use of Highly Superheated Steam in Locomotives. Gilbert E. Ryder. Presents the advantages claimed and illustrates and describes a superheater and gives general discussion. Ills. 10500 w. S & S-W Ry Club—Jan, 1912. No. 32457 D.

Lubrication

Locomotive Valve and Cylinder Lubrication in Connection with Saturated and Superheated Steam. Dr. P. H. Conradson. The qualities a suitable oil should possess are explained and illustrates and describes apparatus. General discussion. 12500 w. Pro W Ry Club—March 9, 1912. No. 32298 C.

Locomotive Valve and Cylinder Lubrication in Connection with Superheated Steam. P. H. Conradson. On the requirements and the requisite qualities in a valve oil to suit the conditions. Ills. 3500 w. Pro S & S-W Ry Club—Jan, 1912. No. 32458 D.

Forced Feed Lubrication of Driving Boxes. Explains the principle of the force feed lubricator. 2000 w. Ry & Loc Engng—April, 1912. No. 31747 C.

Maintenances

Rolling Stock Maintenance at Worcester, Mass. An account of efficient service rendered by comparatively old shops. Ills. 5000 w. Elec Ry Jour—April 6, 1912. No. 31847.

Car and Track Maintenance in Richmond and Norfolk, Va. Reviews the work of the past year. Ills. 3500 w. Elec Ry Jour—April 6, 1912. No. 31846.

Motor Cars

A New Gas-Electric Car. Illustrated description of a self-propelled car introduced on the Canadian Northern Ry. 700 w. Can Engr—April 25, 1912. No. 32442.

Petrol-Electric Car for Suburban Traffic, Great Central Railway. Illustrated description of a car recently placed in service in England. 1000 w. Ry Gaz, Lond—April 12, 1912. No. 32258 A.

Shop Practice

Machining Locomotive Cylinders. Franklin D. Jones. Illustrates and describes practice at the Juniata shops of the Pennsylvania R. R. 2500 w. Mach (Ry Ed)—April, 1912. No. 31862 C.

Shops

The Westinghouse Air Brake Shops. Ethan Viall. Illustrates and describes tools and shop operations on air and pump cylinders, and hose couplings. 2000 w. Am Mach—April 11, 1912. No. 31858.

The New Freight Car Shops at Recklinghausen (Die neue Güterwagen-werk-

stätte in Recklinghausen). Herr Rutkowski. Details of yard facilities and shop construction designed to effect rapid repairs to freight cars. Ills and diagrams. Serial. 1st part. 6000 w. Glasers Ann—Apr. 1, 1912. No. 32032 D.

Spark Arresters

Locomotive Spark Arresters (Funkenflug-schaden der Dampflokotiven). Herr Winkler. General review of the progress made in fire protection from spark prevention. 3500 w. Glasers Ann—Mar. 5, 1912. No. 32005 D.

Standardization

Report of Standing Committee on Revision of M. C. B. Rules of Interchange. Gives report and discussion. 7500 w. Pro Ry Club of Pittsburgh—March 22, 1912. No. 32404 C.

Tires

Tests on the Hardness of Tire Material by the Kohn-Brinell Method (Harteuntersuchungen an Radreifenstoff nach dem Kohn-Brinellschen Kugeldruckverfahren). Editorial on the advisability of using this method. 2500 w. Stahl u Eisen—Mar. 21, 1912. No. 32010 D.

An Electrical Process for Heating Tires (Das Anwärmen von Radreifen auf elektrischen Wege). R. Börnecke. A process for tire heating preparatory to shrinking on car wheels. Ills. 2100 w. Stahl u Eisen—March 14, 1912. No. 32008 D.

Train Lighting

A Recently Installed System of Train Lighting. Illustrates and describes a system developed at Silvertown, England, in which the dynamo is driven by the coach axle. 1000 w. Sci Am Sup—April 13, 1912. No. 31949.

NEW PROJECTS

Grand Trunk Pacific

The Grand Trunk Pacific Railway. Brief illustrated account of the development of this important line, wholly within Canadian territory. 900 w. Can Engr—April 25, 1912. No. 32441.

Hudson Bay Route

The Hudson Bay Route: A New Outlet for Canadian Wheat. Avarad Longley Bishop. Abstract of an article in the *Yale Rev.* Explains the proposed route and discusses the difficulties and general outlook for the project. 4000 w. Ry Age Gaz—April 26, 1912. No. 32377.

Trans-African

The Proposed Trans-African Railway (Le Project de Chemin de Fer Trans-africain). Robert Doucet. Studies on proposed routes for such a project, connecting with such lines already constructed. Maps. 3000 w. Questions Diplomatiques et Coloniales—Apr. 1, 1912. No. 32075 D.

PERMANENT WAY AND BUILDINGS

Construction

Twin City—Twin Ports Line of the Soo. Map and illustrated description of the construction of the closing section of the

direct low grade route from St. Paul and Minneapolis to Superior and Duluth. 2000 w. Ry Age Gaz—April 12, 1912. No. 31944.

Maintenance

See same heading, under *Motive Power and Equipment.*

Pumping Stations

A Reinforced Concrete Infiltration Well and Pumping Plant. Frederick N. Hatch. Brief illustrated description of the design, equipment, and construction of a pumping station at Silver Grove, Ky., for the C. & O Ry. 2000 w. Pro Am Soc of Civ Engrs—April, 1912. No. 32379 F.

Rails

The Development and Use of Rails. P. H. Dudley. Abstracts of two papers read at the Indiana Railway Commission's hearing on this question. 4000 w. Ry Age Gaz—April 26, 1912. No. 32375.

Rail Failures Due to Eccentric Loading. C. A. Morse. Considers that stresses resulting from the use of the present sections under coned wheels exceed the elastic limit of the metal. Ills. 1000 w. Ry Age Gaz—April 19, 1912. No. 32217.

Standard Gauge

The Australian Railway-Gauge Problem. Editorial review of dispute over the question of standard gauge. 2500 w. Engng—April 5, 1912. No. 31998 A.

Stations

New Northern Central Station at Baltimore. Illustrated description. 400 w. Ry Age Gaz—April 26, 1912. No. 32378.

Memphis Union Station. Illustrated description. 1500 w. Ry Age Gaz—April 12, 1912. No. 31946.

Tanks

The Merits and Demerits of Reinforced Concrete Tanks for Railway Water Service. From the Committee report on Water Service of the Am. Ry. Engng. Assn. Ills. 3000 w. Engng & Con—April 24, 1912. No. 32329.

Ties

The Manufacture of Cross-Ties for Preservative Treatment. Howard F. Weiss. From an address before the Am. Wood Preservers' Assn. Discusses important points in manufacture. 2000 w. Ry Age Gaz—April 19, 1912. No. 32222.

See also Timber Preservation, under CIVIL ENGINEERING, *Materials of Construction.*

Track Elevation

Union Station and Grade Separation in Joliet. Illustrates and describes the extensive work involved in elevating tracks and providing for increased passenger service. 3500 w. Ry Age Gaz—April 5, 1912. No. 31802.

TRAFFIC

Freight

Rotterdam's Import Railway Freight (Het spoorweggoederenvervoer te Rotterdam). W. F. H. van Rijckervorsel. Statistics on the amount and character of

goods handled by the railways. Diagrams. 4500 w. De Ingenieur—Mar. 9, 1912. No. 32072 D.

Freight Handling

Handling the Traffic at the Delhi Durbar. Lewis R. Freeman. An account of the successful methods of handling the enormous traffic. 2500 w. Ry Age Gaz—April 19, 1912. No. 32219.

Railway Bill

The Railway Bill. A discussion of Bill No. 124, affecting British railway rates. 3000 w. Engr, Lond—April 12, 1912. Serial. 1st part. No. 32283 A.

Rates

An Interesting Rate Decision by the Canadian Railway Commission. The decision relating to the case of the Dawson Board of Trade versus the White Pass & Yukon Route, rescinding an order of Jan. 18, 1911, which reduced freight and passenger rates. 2000 w. Ry Age Gaz—April 12, 1912. No. 31943.

MISCELLANY

China

Notes on the Chinese Railways. J. Simon. Reviews the history of the introduction of railways. Maps. 10900 w. Bul Int Ry Cong—April, 1912. No. 32359 G.

Economics

Opportunities for Economy on Railways. L. C. Fritch. This fourth article of a series discusses how to reduce the number of personal injuries and the amount of loss and damage. 4000 w. Ry Age Gaz—April 12, 1912. No. 31945.

Eritrea

The Eritrean Railway. Massaua-Asmara-Agordat (La Ferrovia Eritrea Massaua-Asmara-Agordat). Details of the construction and equipment of the lines Massaua to Asmara and Asmara via Cheren to Agordat in Africa. Ills. 6500 w. Ingeg Ferro—March 15, 1912. No. 32313 E.

Foreman

The Problem of the Section Foreman. Contributions received in a prize contest, discussing methods of providing a satisfactory and sufficient supply. Also editorial. 9000 w. Ry Age Gaz—April 19, 1912. No. 32220.

France

The State Railways of France. Editorial review of the State railway system, its beginnings, results, and condition of working. 5000 w. Engng—April 12, 1912. No. 32277 A.

Opportunities

Opportunity in the Railway Business. Samuel O. Dunn. Address delivered in Chicago, on the opportunities for collegemen in the service. 4000 w. Ry Age Gaz—April 26, 1912. No. 32376.

Problems

Need of Reconciliation Between the Railroads and the Public. Edward L. Suffern. Suggests methods of securing public favor and shows its value to the railroads. 3000 w. Engineering Magazine—May, 1912. No. 32345 B.

Railways and Industrial Progress. Maurice H. Robinson. A brief review of present conditions and problems of the railways of the United States. 8000 w. Pro St. Louis Ry Club. March 8, 1912. No. 31928.

Regulation

The Future of Railway Regulation. Charles A. Prouty. Abstract of an interesting address at the annual dinner of the Traffic Club of Pittsburgh. 4000 w. Ry Age Gaz—April 5, 1912. No. 31805.

What Is the Matter with the Railways? F. A. Delano. Address before the Convention of Commercial Assns. of the State of Mich. A criticism of methods of regulation and of labor unionism. 2500 w. Ry Age Gaz—April 19, 1912. No. 32215.

Russia

Russian Railway Notes. Illustrated account of present conditions and proposed extensions. 1500 w. Far East Rev—Feb, 1912. No. 31866 N.

Snow

Fighting Snow in Kansas. L. C. Lawton. Describes three severe storms which interfered with transportation and the methods for clearing. Ills. 1500 w. Ry Age Gaz—April 19, 1912. No. 32221.

United States

Railways and Nationalization in the United States, Apropos of a Work by Mr. E. A. Pratt. W. F. Allen. 4700 w. Bul Int Ry Cong—April, 1912. No. 32356 G.

STREET AND ELECTRIC RAILWAYS

Berlin

Memoirs Concerning the Introduction of Electric Traction to the Street, Surrounding and Suburban Railways of Berlin (Denkschrift betr. Einrichtung elektrischer Zugförderung auf den Berliner Stadt-, Ring- und Vorortbahnen). Historical review of conditions. Ills. and maps. 5500 w. Elek Kraft u Bahnen—Apr. 4, 1912. 32067 D.

Brakes

Electro-Magnetic Brakes on the Street Railways of Wiesbaden (Strassenbahnbetriebsmittel mit elektro-magnetischen Schienenbremsen der Stadt Wiesbaden). Herr Berlitz. The Wiesbaden plant and the application and operation of these brakes on street railways. Ills. 2500 w. Elek Kraft u Bahnen—Mar. 14, 1912. No. 32064 D.

Car-Houses

New Fireproof Car Storage House of the Cincinnati Traction Company. Illustrated detailed description of a structure for housing 374 cars. 1200 w. Elec Ry Jour—April 27, 1912. No. 32439.

The New Carhouse and Line Department Building of the Rockford Interurban Railway. Illustrated description of a modern fireproof repair shop building and equipment. 2200 w. Elec Ry Jour—April 6, 1912. No. 31845.

Cars

Equipment for the New Stepless Car of the New York Railways Company. Illustrates and describes the novel arrangement and the devices installed. 5000 w. Elec Ry Jour—April 20, 1912. No. 32233.

All-Steel Center-Entrance Car for Brooklyn. Plan and description of an experimental car under construction. 1200 w. Elec Ry Jour—March 30, 1912. No. 31685.

Center-Entrance Car of the Washington Railway & Electric Company. Floorplans, illustrations and descriptions. 1000 w. Elec Ry Jour—April 27, 1912. No. 32440.

Electrification

Electrification. Discussion on this subject as applied to railroads. Ills. 7000 w. Pro N Y R R Club—March 15, 1912. No. 32150.

Recent American A. C. Main Lines (Neuere amerikanische Wechselstrom-Vollbahnen). H. Nordmann. The first number discusses the introduction of electric drive on the Boston and Maine Ry. through the Hoosac Tunnel. Ills. Serial. 1st part. 6500 w. Elek Kraft u Bahnen—Mar. 24, 1912. No. 32066 D.

The Power Requirements of the Gotthard Railway in View of a New Plant for its Electrification (Der Kraftbedarf der Gotthardbahn mit Rücksicht auf die Neuanlagen für deren elektrischen Betrieb). W. Kummer. Studies on the determination of such power requirements. Diagrams. Serial. 1st part. 5000 w. Schweiz Bau—Mar. 9, 1912. No. 32051 B.

Italy

The High-Voltage Monoplane Electric Railway, Rome-Frosinone-Diramazione (La Ferrovia elettrica a corrente monofase ad alta tensione Roma-Frosinone-Diramazione). Jean Pellizzi. Details in the electrical equipment of this road. Ills. and maps. 5200 w. Ingeg Ferro—Mar. 31, 1912. No. 31314 E.

Ithaca

Report on Ithaca (N. Y.) Street Railway. Abstract of results of an investigation made by C. R. Barnes. Compares with other cities of similar size in the State. 4500 w. Elec Ry Jour—April 20, 1912. No. 32234.

Locomotives

Electric Locomotives for the Loetschberg Tunnel. Illustrated general description

tion of the locomotives, one of which was built by the Allgemeine Elektrizitäts-Gesellschaft, and the other by the Oerlikon Works. 2000 w. Ry & Engng Rev—April 27, 1912. No. 32452.

See also Mine Locomotives, under MINING AND METALLURGY, *Mining*.

Maintenance

The Maintenance of Electric Railway Equipment. J. L. Crouse. From a paper read before the Cent. Elec. Ry. Assn. Discusses methods of correcting delays in service and reducing maintenance. 2200 w. Elec Jour—April, 1912. No. 32184.

Rail Corrugations

The Corrugation of Rails. Prof. A. Schwartz and R. G. Cunliffe. Describes laboratory experiments and investigations on actual tracks. Ills. 4500 w. Elect'n, Lond—April 5, 1912. No. 31984 A.

Railless

Railless Traction at Leeds and Bradford. Information concerning trolley omnibuses that have been in service nine months and the future prospects. Ills. 2500 w. Elec Rev, Lond—March 29, 1912. No. 31876 A.

Railless Railways ("Gleislose Bahnen"). A compendium. The "Elektro-Daimler-Stoll" System described by E. Moor; the Lloyd-Köhler, by H. Hinderer, and a description of the Schiemann system. Ills. 4500 w. Zeit d Mitt Motorwagen Ver—Mar. 5, 1912. No. 32061 D.

Shops

Repair Shop Layouts. A compilation of figures from ten shops, most of them recently constructed. Ills. 3000 w. Elec Ry Jour—April 6, 1912. No. 31841.

The Illinois Traction System's New Brass Foundry and General Shop Notes. Illustrated description of new foundry equipment, methods of manufacture and costs of bearings and hardware. 2500 w. Elec Ry Jour—April 6, 1912. No. 31843.

Shop Practice

Shop Notes from Hartford, Conn. A report of effective car maintenance and labor-saving methods. Ills. 3500 w. Elec Ry Jour—April 6, 1912. No. 31840.

Stations

The Interurban Terminal Station of the Ohio Electric Railway at Columbus, Ohio. Illustrated description of a fireproof passenger station and office building. 1200 w. Elec Ry Jour—April 13, 1912. No. 31969.

Trolley Wire

Experiences with Steel Trolley Wire. Abstracts of replies from a number of companies which have been testing the steel wire. 2000 w. Elec Ry Jour—April 6, 1912. No. 31842.

Subways

Cambridge Extension of the Boston Subway. Illustrates and describes details of this work. 2000 w. Ry & Engng Rev—April 27, 1912. No. 32451.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; H, of \$1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

- | | |
|---|---|
| Alliance Industrielle. <i>m</i> . Brussels. | Bulletin de la Société d'Encouragement. <i>m</i> . Paris. |
| American Architects. <i>w</i> . New York. | Bulletin of Dept. of Labor. <i>b-m</i> . Washington. |
| American Engineer and R. R. Journal. <i>m</i> . New York. | Bull. of Can. Min. Inst. <i>qr</i> . Montreal. |
| American Jl. of Science. <i>m</i> . New Haven, U. S. A. | Bull. Soc. Int. d'Electriciens. <i>m</i> . Paris. |
| American Machinist. <i>w</i> . New York. | Bulletin of the Univ. of Wis., Madison, U. S. A. |
| Annales des Ponts et Chaussées. <i>m</i> . Paris. | Bull. Int. Railway Congress. <i>m</i> . Brussels. |
| Ann. d Soc. Ing. d Arch Ital. <i>s-m</i> . Rome. | Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. <i>m</i> . Liège. |
| Architect. <i>w</i> . London. | Bull. Tech. de la Suisse Romande. <i>s-m</i> . Lausanne. |
| Architectural Record. <i>m</i> . New York. | Canadian Architect. <i>m</i> . Toronto. |
| Architectural Review. <i>s-q</i> . Boston. | Canadian Electrical News. <i>m</i> . Toronto. |
| Architect's and Builder's Magazine. <i>m</i> . New York. | Canadian Engineer. <i>w</i> . Toronto and Montreal. |
| Australian Mining Standard. <i>w</i> . Melbourne. | Canadian Mining Journal. <i>b-w</i> . Toronto. |
| Autocar. <i>w</i> . Coventry, England. | Cassier's Magazine. <i>m</i> . New York and London. |
| Automobile. <i>w</i> . New York. | Castings. <i>m</i> . Cleveland, O. |
| Automotor Journal. <i>w</i> . London. | Cement. <i>m</i> . New York. |
| Beton und Eisen. <i>qr</i> . Vienna. | Cement Age. <i>m</i> . New York. |
| Boiler Maker. <i>m</i> . New York. | Central Station. <i>m</i> . New York. |
| Brass World. <i>m</i> . Bridgeport, Conn. | Chem. Met. Soc. of S. Africa. <i>m</i> . Johannesburg. |
| Brickbuilder. <i>m</i> . Boston. | Colliery Guardian. <i>w</i> . London. |
| Builder. <i>w</i> . London. | Commercial Vehicle. <i>m</i> . New York. |
| Bull. Bur. of Standards. <i>qr</i> . Washington. | |

- Compressed Air. *m.* New York.
 Consular Reports. *m.* Washington, D. C.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineer. *w.* London.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Elektricien. *w.* Paris.
 Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering-Contracting. *w.* New York.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Cold Storage. *m.* London.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Jour. N. E. Water Works Assn. *qr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *qr.* London.
 Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Métallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal and Engineer. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *qr.* Philadelphia.
 Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Public Works. *qr.* London.
 Quarry. *m.* London.
 Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Loc. Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Gén. des Chemins de Fer. *m.* Paris.
 Revue Gén. des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
 Signal Engineer. *m.* Chicago.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.



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No. 4

TRANSVAAL GOLD MINING—PRESENT AND FUTURE METHODS

By F. H. Hatch

Dr. Hatch's article is based on a lecture delivered by him in London before the Institute of Civil Engineers, but it is so fully recast and adapted for THE ENGINEERING MAGAZINE as to constitute practically an independent review of the subject. The clarity, conciseness, and authority of the presentation make it a most valuable record of present practice, and the forecast of the life and activity of the Rand is of great importance.—THE EDITORS.

GOLD was discovered on the Witwatersrand in 1885. Since that time the goldfield, which extends a distance of about 46 miles between the Springs and Randfontein, has produced gold valued at more than \$1,105,000,000. The production last year amounted to \$170,487,900, as compared with \$155,730,260 in 1910. The annual yield is now more than double what it was in 1903 and the outlook points to an improved production in the next few years. Already it is greater than that of any other country. It is more than double that of the United States and nearly three times as large as the Australian production. It will be of interest to review briefly the conditions under which gold is found on the Rand and the modern mining and metallurgical methods practiced in South Africa.

GEOLOGICAL OCCURRENCE OF THE GOLD

The Witwatersrand mines are situated on a plateau between 5,000 and 6,000 feet above sea level. In the vicinity of Johannesburg, ranges of low hills rise some 200 to 300 feet above a rolling country. These hill ranges run east and west with the strike of the prevailing rock formations, the most northerly forming an abrupt escarpment above the granite, which justifies the name Rand (*anglicé* edge or escarpment) for the district.

The gold is found in a series of conglomerates locally known as bankets. The geological formation in which these auriferous conglomerates occur is known as the Witwatersrand System. It consists of a group of sediments some 20,000 feet thick, separated by a great unconformity from

the old schists and conglomerates of the Swaziland System beneath it. Since no fossils have been found in it, its age is unknown, but it is certainly of great geological antiquity—since it is separated from the base of the Waterberg sandstone (= Table Mountain sandstone of early Devonian age) by 25,000 feet of strata and by more than one great unconformity. It is therefore probably of pre-Cambrian age; and it has been suggested (but without any real basis for correlation) that it is the South African equivalent of the Algonkian of North America. Its position in the South African succession as developed in the Transvaal is as follows:—

ity).—Volcanic lavas and breccias, boulder beds and conglomerate (Elsberg Series).

Witwatersrand System (unconformity).—Upper and Lower.

Swaziland System.—Schists and granite.

The "Main Reef Series" of conglomerates has been worked for its valuable gold content more or less continuously for a distance of 46 miles. The comparison of sections taken through the series at different points along the strike shows that there is a considerable variation both in the number of beds of conglomerate and in the amount of quartzite between them. Individual beds are



GEOLOGICAL MAP OF SOUTHERN TRANSVAAL
Courtesy of Mining and Scientific Press

Karoo System (unconformity).—(With basal Dwyka conglomerate).

Waterberg System (unconformity).—(= Table Mountain sandstone of the Cape).

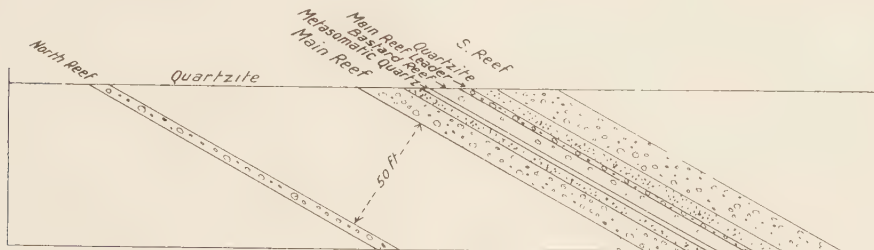
Potchefstroom System (unconformity).—Pretoria Series. Dolomite Series. Black Reef Series, with basal conglomerate.

Ventersdorp System (unconform-

lenticular, swelling in places to a considerable thickness and tailing off in other places to a mere parting. In spite of this variation along the strike, the different members of the Main Reef Series have received a nomenclature generally used throughout the Rand. The highest member is termed the South Reef since its outcrop lies furthest to the south.

Then follow in downward succession the Main Reef Leader, the Main Reef, and the North Reef. Both the South Reef and the Main Reef are in reality

average probably making up 3 per cent of the rock; and is of great importance both from a scientific and an economic aspect, owing to the fact



SOUTH MAIN REEF SERIES OF CONGLOMERATES IN THE KNIGHTS DEEP MINE, EAST RAND
Courtesy of Mining and Scientific Press

composed of a variable number of small seams of conglomerate, and it is only by grouping these that any semblance of continuity is maintained. The most individualised bed, at any rate for a considerable proportion of the mines, especially in the central portion of the Rand, is the Main Reef Leader. Usually it is of small thickness, but has a comparatively high gold content; while a characteristic feature is a layer of large pebbles on the footwall. All these conglomerates consist largely of rolled fragments of pebbles of dark-colored vein quartz, but fragments of quartzite, banded chert, and slate also occur, these having a much more angular shape than the quartz pebbles. The pebbles, which are worn smooth and round by attrition and have been obviously water-borne, lie in a matrix which originally consisted of quartz sand, but which by the abundant deposition of infiltrated silica has been cemented to a compact mass of quartz in which even the boundaries of the pebbles are difficult to distinguish on freshly fractured surfaces of the banket.

Next in importance to the secondary quartz of the matrix which has been responsible for wide-spread silification is iron pyrites which, in like manner, has caused an extensive pyritisation. It is present everywhere and in places abundant, on the

that the gold is in intimate association with and in genetic relation to this mineral. Thus it is found to occur in angular sub-crystalline particles attached to the periphery of individual crystals of pyrites. It also occurs in the interstices between aggregates of pyrites crystals, and in some cases completely surrounding spherular concretions of pyrites.



WEATHERED SURFACE OF BANKET, SCALE $\frac{1}{4}$
Courtesy of Mining and Scientific Press

The so-called "buck-shot pyrites" of the Rietfontein mine is frequently found plastered over with gold. When graphitic carbon is present

there is also an intimate relation between it and the gold, which occurs thickly incrustated upon it. Gold is also found in the secondary quartz which has cemented the cracks of broken quartz pebbles in the banket beds.

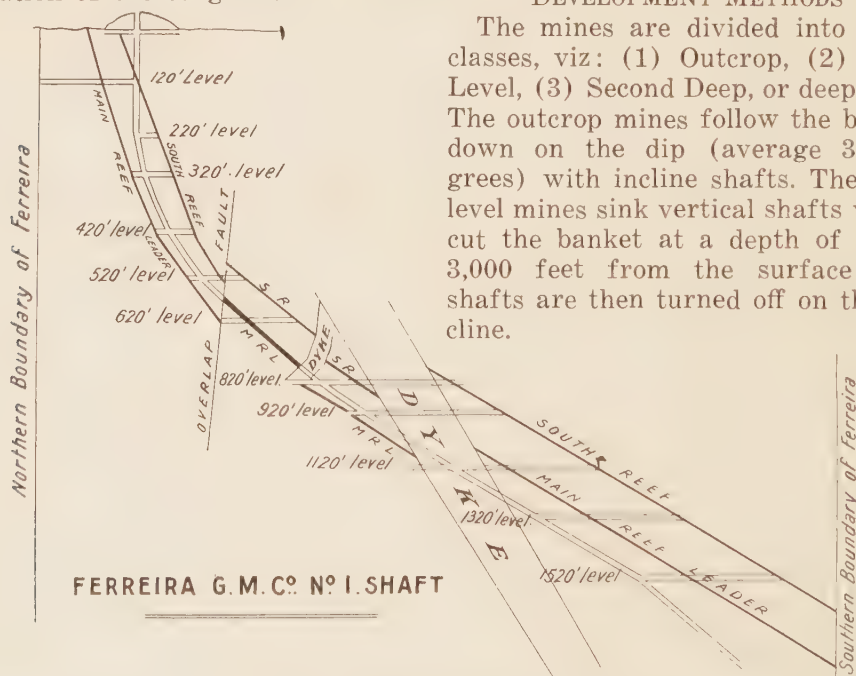
That the gold has been precipitated in the banket at various periods in its history is clear; on the other hand there is no case on record of a nugget or of a grain or flake of gold which bore on its surface any signs of detrital origin or in any way resembled alluvial gold. The conclusion can scarcely be avoided therefore that the gold owes its present position in the banket to precipitation at some period long subsequent to the sedimentation of the conglomerate.

ment, since it is found that by grinding to a sufficient degree of fineness the noble metal is liberated from its intimate association with iron pyrites and may be successfully removed by a weak solution of cyanide of potassium.

The gold content of the banket* varies. The average grade worked by all the mines last year was \$6.80. There is, however, an enormous quantity of banket, containing an average gold content of about \$5 to the ton, and it is becoming apparent that, with the extension of the scale of operations and consequent reduction of the cost of working, the bulk of this ore will be mined.

DEVELOPMENT METHODS

The mines are divided into three classes, viz: (1) Outcrop, (2) Deep Level, (3) Second Deep, or deep deep. The outcrop mines follow the banket down on the dip (average 30 degrees) with incline shafts. The deep level mines sink vertical shafts which cut the banket at a depth of about 3,000 feet from the surface; the shafts are then turned off on the incline.



TRANSVERSE VERTICAL SECTION FERREIRA MINE. A TYPICAL OUTCROP MINE
Courtesy of Mining and Scientific Press

Although intimately associated with pyrites, it is as shown above a mechanical association; the gold exists in a finely divided condition locked up in the pyrites but not chemically combined. It is therefore suited to a simple metallurgical treat-

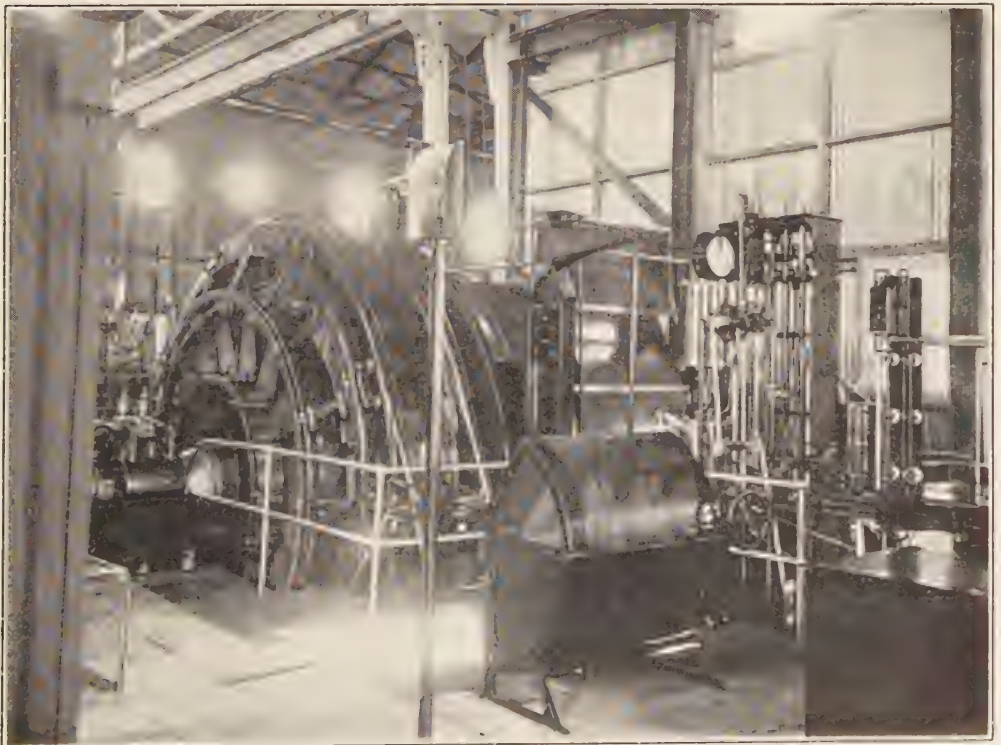
POWER

Electric power is supplied by the Victoria Falls and the Transvaal Power Company, whose power plants

* "Banket" is a Dutch word locally applied to the Witwatersrand conglomerate on account of its supposed resemblance to an almond cake made by the Boers.



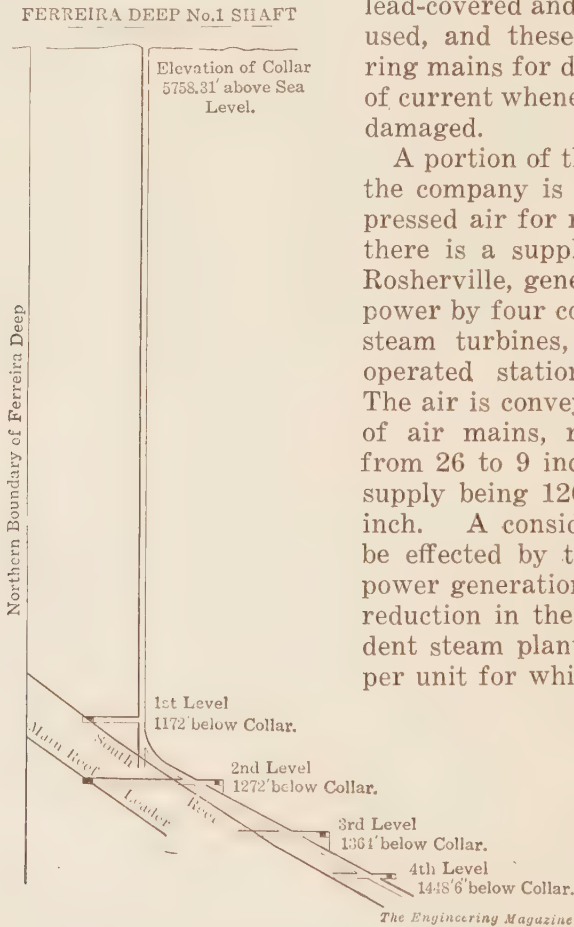
SWITCHBOARD, BRAKPAN GOLD MINES SUB-STATION
Power taken from Victoria Falls Power Co.



WARD-LEONARD HOIST, MODDER B. MINES

—at Brakpan, Germiston, Rosherville and Vereeniging—all use local coal. As yet no water-generated power is transmitted to the Rand.

The Victoria Falls and Transvaal Power Company supplies electric power at one cent per unit.



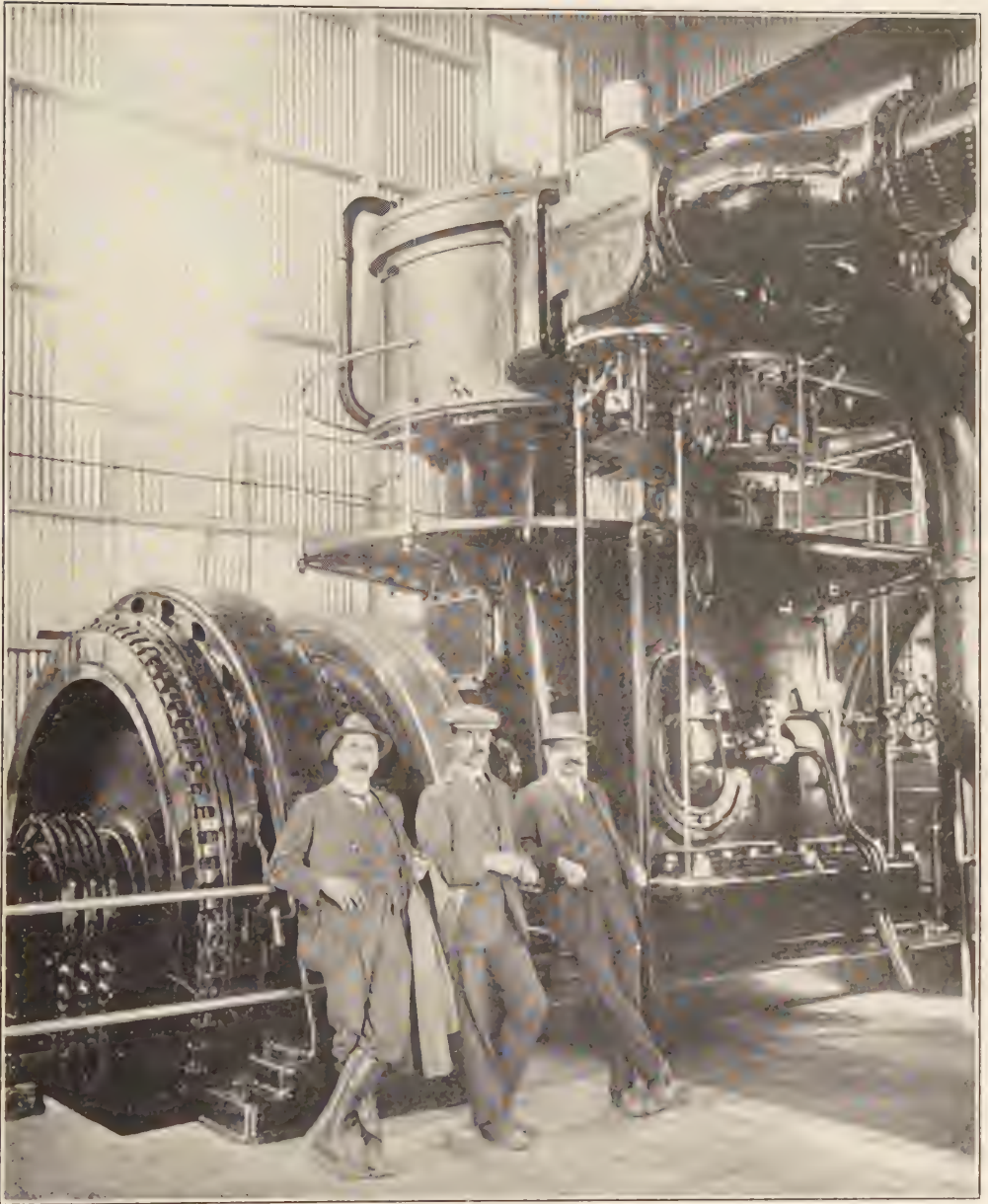
TRANSVERSE VERTICAL SECTION THROUGH FERREIRA DEEP MINE. CENTRAL RAND
A TYPICAL DEEP-LEVEL GOLD MINE
Courtesy of Mining and Scientific Press

It has a central generating station of 50,000 kilowatts at Rosherville, one of 18,000 kilowatts at Simmer Pan, one of the 9,000 kilowatts at Brakpan, and a fourth station of 20,000 kilowatts at Vereeniging. At all of these stations the power is generated by high-speed steam turbines. Transmission is effected by overhead lines at 40,000 volts along the Rand

and at 80,000 volts from Vereeniging, a distance of 30 miles, and by underground cables at 20,000 volts. The length of the overhead lines, including Vereeniging, is 150 miles; that of the underground cable is 35 miles. Underground paper-insulated lead-covered and armoured cables are used, and these are furnished with ring mains for duplicating the supply of current whenever the main cable is damaged.

A portion of the power supplied by the company is in the form of compressed air for rock drills. For this there is a supplementary station at Rosherville, generating 16,000 horsepower by four compressors driven by steam turbines, and an electrically operated station at the Robinson. The air is conveyed through 20 miles of air mains, ranging in diameter from 26 to 9 inches, the pressure of supply being 120 pounds per square inch. A considerable economy will be effected by this centralisation of power generation and the consequent reduction in the number of independent steam plants. From the price per unit for which the Victoria Falls

and Transvaal Company are supplying power, the cost per one horsepower utilized continuously day and night for a whole year can be calculated. It works out at £14. It is not so easy to arrive at the average cost of a horse-power year on the mines prior to electrification, but it is stated to have been £28. In any case, the saving due to the substitu-



SIXTY-FIVE DRILL BELLISS-MORCOM AIR-COMPRESSOR DIRECT-CONNECTED TO THREE-PHASE INDUCTION MOTOR, MODDER B MINE

tion of the electric motive power for steam power is undoubted, and there is, moreover, the indirect advantage of greater flexibility and more perfect control.

HOISTING

The outcrop mines were equipped with ordinary drum-hoisting plants

driven by steam. At the present time there are still more steam than electric hoists, but the tendency is to equip new shafts with electric hoists, as they are not only easier to operate but in most cases are cheaper.

The introduction of electric hoists on the Rand has practically decided

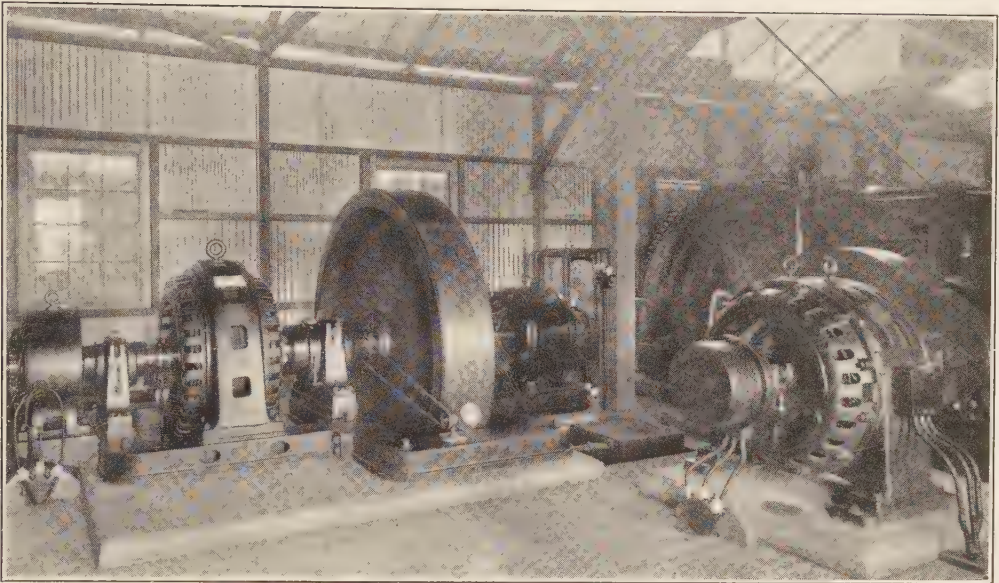


FIRST-MOTION CORLISS HOIST WITH 18 BY 48 CYLINDERS AND 8-FOOT DRUMS, CONSOLIDATED
MAIN REEF

Stood on foundations as shown throughout the entire Boer war; the small parts were stored in the machine shop of the company, which was used as an ammunition factory by the Boers and was destroyed by an explosion, the parts thus lost being replaced after the war. The Wellman-Seaver-Morgan Co.

the long debated question of winding at great depths, in favour of stage winding as against a single lift. By the adoption of a large unit of haul-

ing and a suitable arrangement of loading boxes, the loss due to the repeated handling of the ore can be reduced to a minimum.



FLYWHEEL GENERATOR AND WINDING MOTOR, CINDERELLA DEEP MINE
Westinghouse Electric and Manufacturing Co.

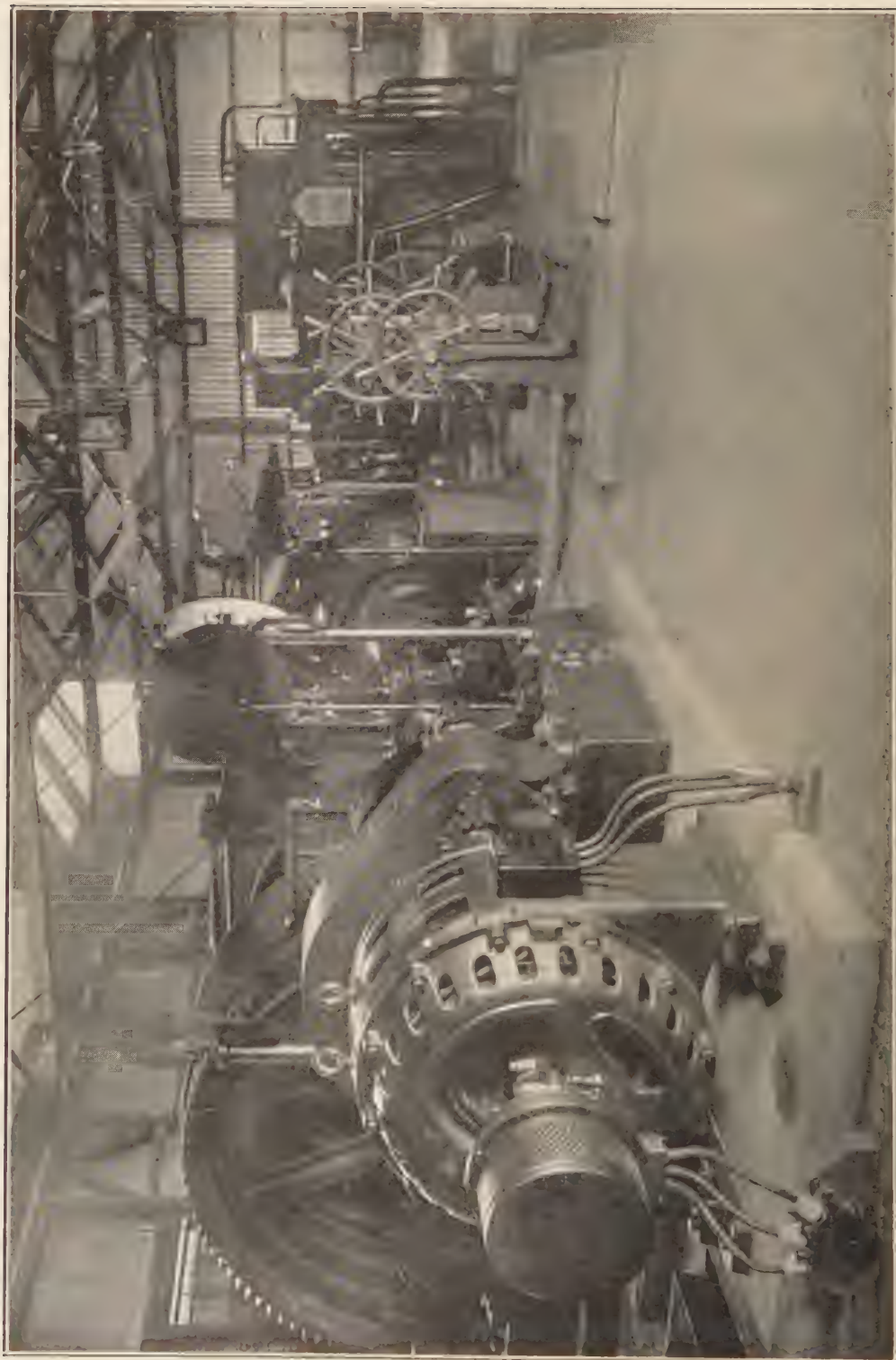
In the new seven-compartment shaft of the Crown Mines, the ore is to be raised in 8-ton skips, and even larger units have been adopted at Kimberly as, for instance at the Wes-selton, Bultfontein, and Dutoitspan mines, where 11-ton skips are in use. Underground electric winders, to serve the inclines from the bottom of the vertical shafts, are being installed in several mines. They will also be employed for winding in the deeper vertical shafts, when the depth reached is beyond the economic limit of a single lift.

UNDERGROUND HAULAGE

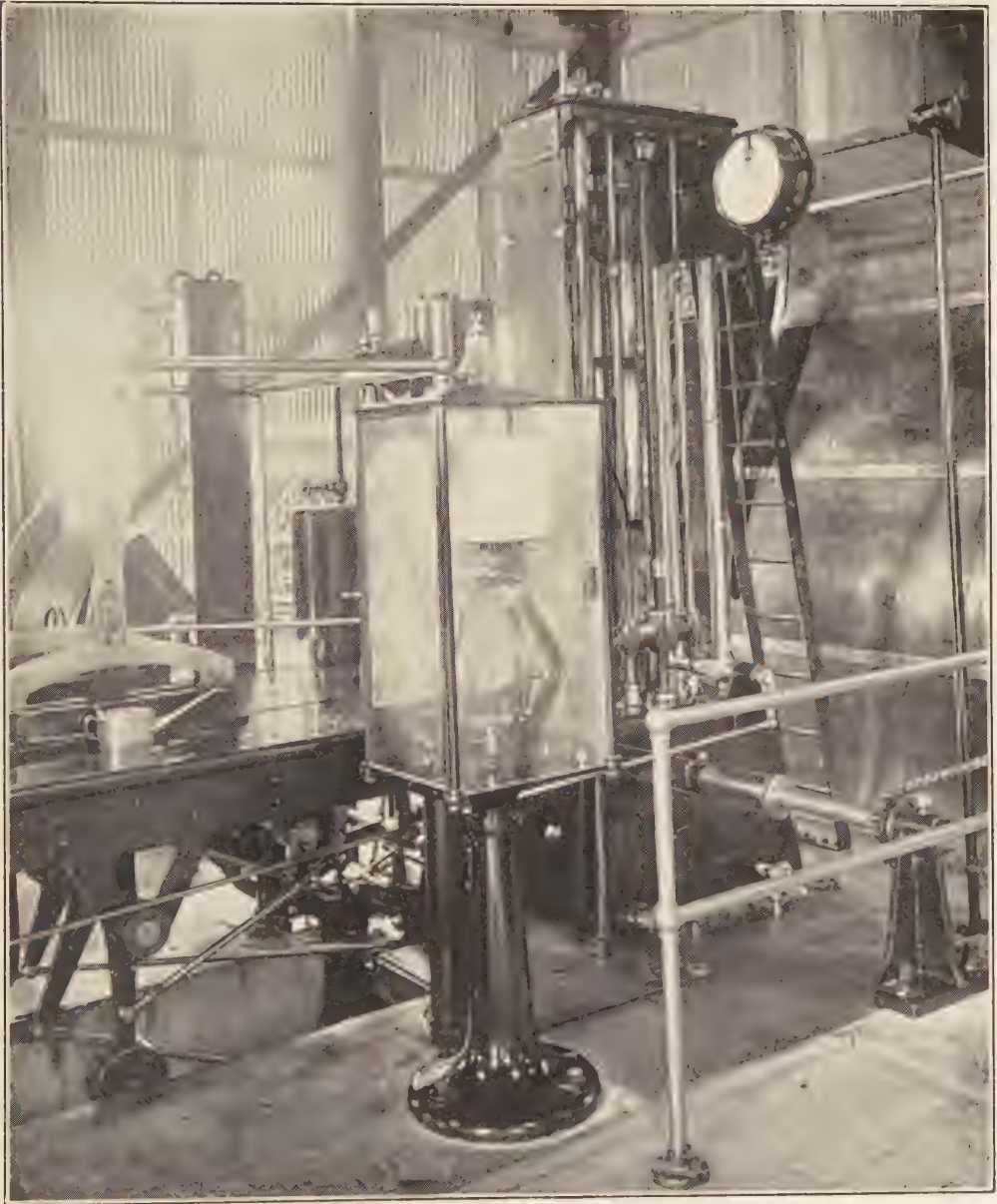
The ore broken in the stopes was formerly trammed on light rails from the stoping boxes to the loading stations at the shaft, in four-wheeled trucks of 12 to 16 cubic feet capacity, the motive power being hand labour. The ore was transported on every level through tortuous and badly graded roads of the customary small dimensions. Scarcely any other method was then possible. Some years ago an experiment was made at the Langlaagte Deep mine with a

monorail system of tramping, and also at the New Klienfontein mine. These experiments, however, were not successful, owing to the first high cost of the plant.

Under the changed conditions now prevailing on the Rand, due to the enormously increased size of the properties brought about by recent amalgamations, and the consequent possibility of concentrating a large output on fewer main hoisting shafts than heretofore, the establishment of an entirely new system of underground transport is being accomplished. It is now becoming recognized that the rock broken in the stopes can be economically dealt with only by handling on a few main haulage-levels, situated at great intervals apart and driven straight from point to point in the foot wall of the reef. The rock mined above each haulage level can be delivered through vertical or inclined passes, and, should it be necessary to feed the haulage with rock mined below the level, such rock can be raised through inclined roads by mechanical haulage or electric



WINDING MOTOR, HOIST OF THE CINDERELLA DEEP MIN. JOHANNESBURG, SOUTH AFRICA
Westinghouse Electric and Manufacturing Co.



DEPTH INDICATOR AND SPEED INDICATOR, WARD-LEONARD HOIST, MODDER B. MINES

hoists. These main haulage roads, which are intended to serve also as the intake of the fresh-air current, can, on account of their economic importance, be constructed of large dimensions. They can also be carefully graded and equipped with heavy rails. Such a system is being carried into effect at the Crown Mines, where

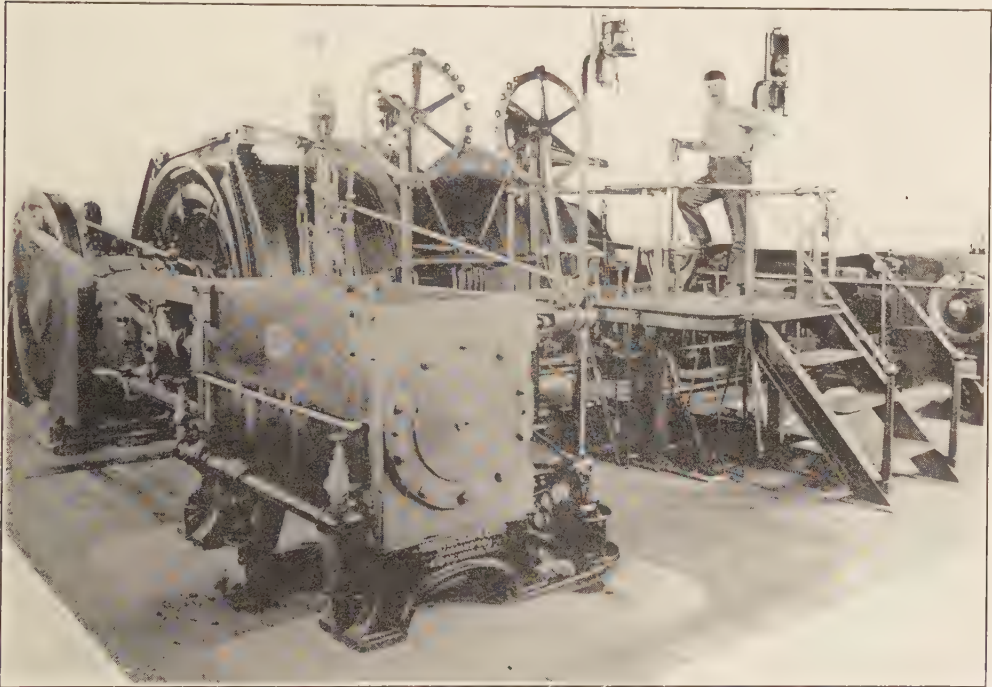
the two main hoisting shafts are to be connected, at a vertical depth of 2,200 feet, by a main haulage level $14\frac{1}{2}$ feet wide. This gallery is being driven, in the foot wall of the reef, from one end of the property to the other, and when completed will be 3 miles long. It will be operated by an electrically driven endless-rope haul-



THE MODDER B. MINE

age, so arranged that the ore may be delivered to either shaft. It is estimated that the two shafts between them will handle from 9,000 to 10,000 tons of ore per diem. Other main haulage levels will be driven as required, at intervals of 600 feet vertically. Similar work is being done at the New Modderfontein mine and at the Modder B. mine and, no doubt, the system will become general.

of the reef before even the ore body has been blocked out, such as is being carried into effect on the Crown, New Modderfontein, and Modder B. mines, is an interesting indication of the confidence of the Rand engineers in the relative permanence of the gold-content of the banket formation, as compared with quartz veins. The big intervals at which the reef levels are now being driven is another indica-



CORLISS FIRST-MOTION HOIST, OF A TYPE COMMON ON THE RAND

Similar plants are installed at the Simmer and Jack East, Simmer and Jack West, South Rose Deep, and South Geldenhuis. Corliss cylinders 24 by 60, drums 10 ft. diameter and 4 ft. face, powerful band friction clutches and post brakes. Hoist at a speed of 3,000 ft. per minute. Wellman-Seaver-Morgan Co.

Endless-rope haulage can be used with advantage only where the roads are straight. When they have many curves it is preferable to draw the ore trains either by petrol locomotives, as at the Langlaagte Deep, or by electric locomotives, as at Geduld mine. With the latter system some difficulty is experienced in completely protecting the raw and careless natives from the electric current.

The bold policy of driving these straight haulage roads in the footwall

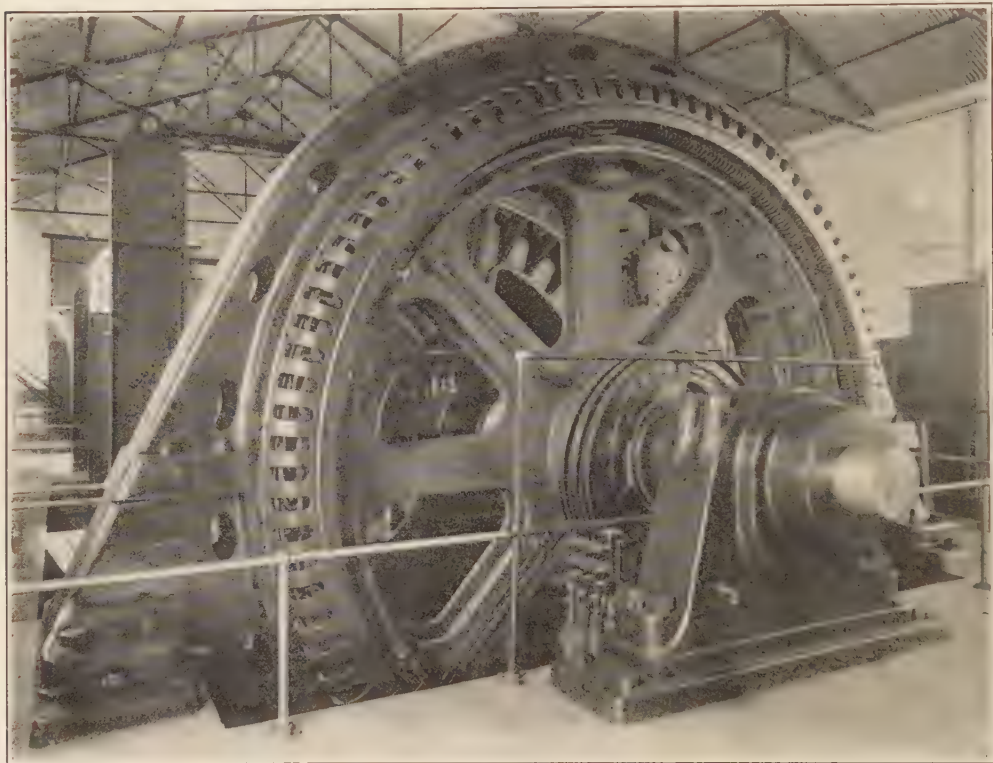
tion of the same confidence. It is proposed in the New Modderfontein mine to drive the levels from 500 to 600 feet apart and the main haulage levels in the footwall of the reef from 1,700 to 2,000 feet apart.

MACHINE DRILLING

The breaking of the ore in the stopes is performed to a very large extent by hammer and jumper drill work, and since this work absorbs the larger portion of the native labour employed on the Rand, it constitutes

a serious problem, not only on account of the perennial difficulty of obtaining a sufficient supply of natives, but also on account of the time lost in lowering and raising such large numbers of men in the shaft.

blasting charges used that often it could not afterwards be eliminated by sorting. The large blasting charges also were found to weaken the roof, so that a larger number of pillars had to be left for its support than was the

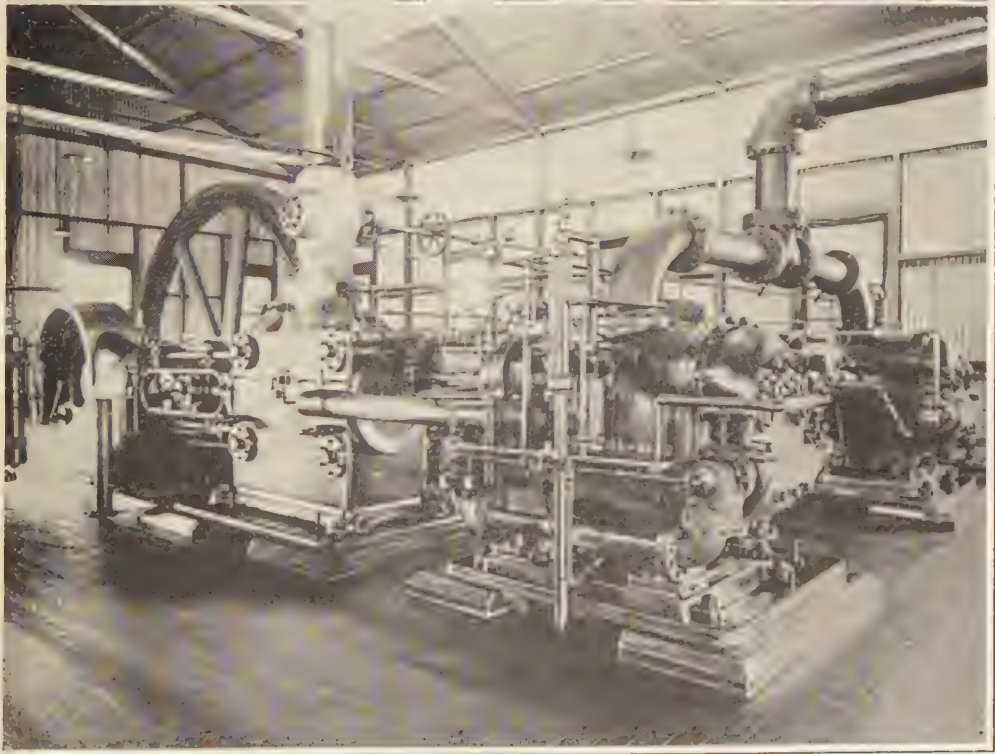
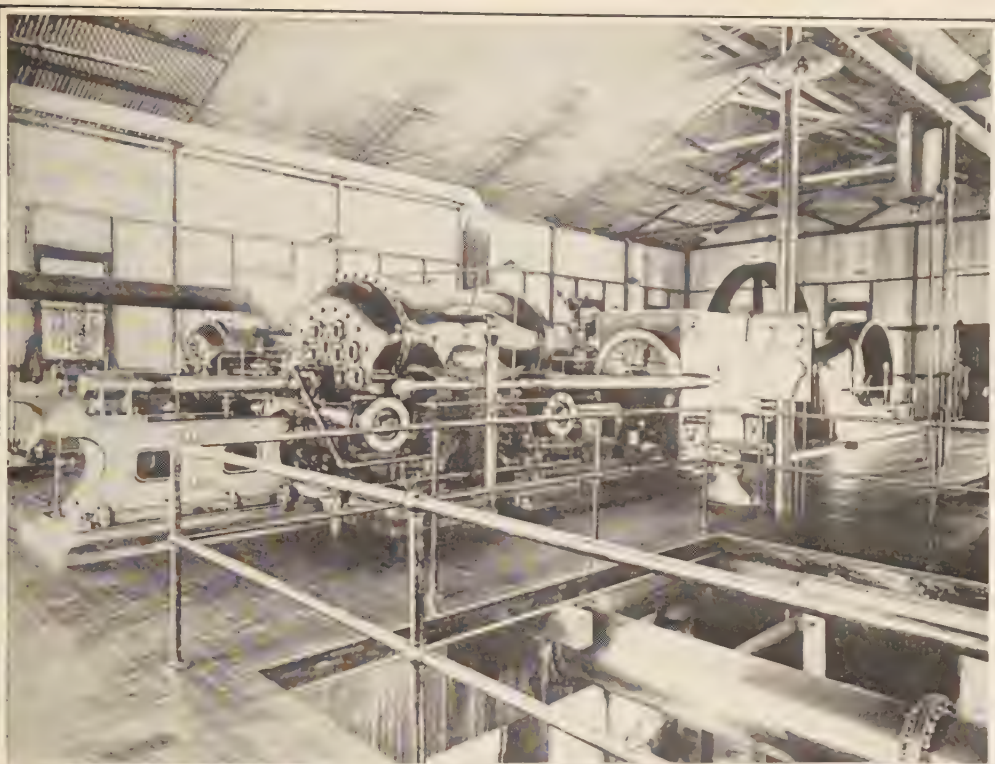


THREE-PHASE INDUCTION MOTOR DIRECT-CONNECTED TO HOIST, BRAKPAN GOLD MINES

The problem can be solved only by increasing the efficiency of the native labourer, or in other words by increasing the tonnage broken per native employed. The use of machine drills for stoping was formerly not looked upon with much favor. There were several reasons for this. First, the machine used was the heavy drill employed for sinking and development work, and with this type it was impossible to work in narrow stopes without breaking a large amount of waste. Then the bands of barren quartzite, with which the payable conglomerate is often interstratified, suffered such pulverisation by reason of the large

case with hand drilling. Only in wide stopes, on a large homogeneous reef with good walls, could these drills be used to economic advantage. The necessity for a good stoping drill for narrow reefs, however, has become more and more pressing with the extension of the mining industry, with which the supply of native labour for hand drilling has not kept pace.

The Chamber of Mines of the Transvaal carried out a series of drilling trials in 1909 with the view of determining the best drill suited for local work. The winning machines were of the reciprocating percussive type. The names of the winning



AIR-COMPRESSOR PLANT AT SOUTH AFRICAN GOLD MINES

Above, one of two compressors each 25 and 50 and $48\frac{1}{4}$ and $29\frac{1}{4}$ by 60, Corliss inlet-valves and poppet discharge valves, for Simmer Deep and Robinson Deep. Below, air compressor 22 and 44 and 20 by 42, duplex air cylinders, Corliss inlet and direct-lift discharge valves. Both by Ingersoll-Rand Co.

drills are given in the following table, together with the aggregate length drilled each, the average drilling speed over the total time, and the cost of drilling per foot.

Machine	Length drilled ft.	Average drilling speed	Cost drilled cents
Holman 2½ inch	12,779	0.742	20.0
Siskol	14,083	0.818	19.8
Holman 2¾ inch	11,744	0.682	21.0
Chersen	11,781	0.684	23.8

These costs compare favourably with the cost of hand drilling, which is rarely less than 26 cents per foot drilled. The tonnage broken is 6 to 5 in favor of the machine, while the cost of the explosives is as 6 to 5 in favor of native labour. Since the cost of native labour tends to increase and this item amounts to 6 cents per foot drilled in machine drilling, as against 20 cents hand drilling, this



JACK HAMMER BREAKING UP ROCK AFTER A BLAST, GELDENHUIS MINE, WITWATERSRAND
Ingersoll-Rand Co.

also is in favor of machine drilling. It may, therefore, be taken as established by this competition that machine drilling in moderately narrow stopes costs no more, and perhaps even less, than hand drilling by natives. Hundreds of small drills drilling holes to take a $\frac{7}{8}$ -inch explosive charge are already employed for stoping on the Rand, and their average duty is about $\frac{3}{4}$ fathom per shift. For stoping very narrow and low-grade reefs, hand labour has still to be used, but it is hoped that a drill

was drawn off as required from the stope boxes. With the dips of 25 to 30 degrees obtaining in most of the deep-level mines, the broken rock requires to be assisted down the stope-floors by shoveling, or lashing, as it is called in miners' parlance. Only in the extreme East Rand, where the reef lies very flat, dipping only from 8 to 10 degrees, is it possible to fill the trucks at the stope faces and to run them thence direct to the tramming levels. Hand shoveling is uneconomical and, moreover, is detri-



INGERSOLL-RAND DRILL IN A NARROW STOPE, MEYER & CHARLTON MINE, WITWATERSRAND

capable of doing even this class of work will eventually be involved.

STOPE CONVEYORS

The handling of the broken rock in the stopes, from an economic point of view, is scarcely less important than its haulage on the levels. Everything depends on the angle of dip of the reef. In many of the outcrop mines of the Central Rand, the high dip of the reef permitted the rock broken in the stopes to find its way by gravitation to the tramming level, where it

mental to health, on account of the dust it raises. Consequently, several attempts have been made to substitute for it some automatic conveyor system for handling the broken rock. Mr. E. J. Way, M. Inst. C. E., has described a method employed by him at the New Kleinfontein Mine, by which he effected a very large reduction in the number of unskilled labourers engaged in shoveling rock down the stopes. Mr. Way's stope conveyor consists of shaking shoots made of

iron plates, slightly troughed, 18 inches wide and 8 feet long. The whole shoot varies in length according to the state of development of the stope, from 32 to 224 feet. These shoots are suspended by short chains from the roof next to the working force of the stope, and are operated by one or more men, according to their length, who pull at ropes attached to the upper ends of the conveyors. Kept in motion by the jerks thus transmitted, the ore slides down the conveyors and is discharged at their lower ends into the stope boxes, or directly into trucks at the tramming level. Being easily dismantled, the conveyors can be quickly taken down before and put up after each blast. When the working force has advanced about 6 feet, a series of small holes are drilled in the roof to take the hook bolts carrying the chains. Many of these shaking shoots are now in use on the Rand and are mostly hung from the rope stretched taut along the roof. Each length of shoot is attached by chains, hooked into clips permanently fastened to the rope at the correct intervals. Before blasting the shoots are unhooked from the rope, which in most cases can be left on the roof by drilling a few holes in line, without having to keep the exact distance in the shoot lengths.

SAND FILLING.

The removal of a gold-bearing conglomerate bed which, except for its somewhat steeper dip, may be compared to a coal seam, leaves an open space which is not allowed to fall in, as in a coal mine worked in the long-wall retreating system, but is supported over enormous areas by pillars of unworked conglomerate in the stopes, by ribs left above and below the drives, and by pillars left to ensure the safety of the shafts, supplemented, in some cases, by the stowing of waste rock. These methods have sufficed in the past to keep open

the stopes and drives and to protect the shafts. Owing to the robbing of the stope pillars in the outcrop mines, and more especially to the increased pressure of the superincumbent rock mass in the deep levels, serious movements of the hanging wall have lately been making themselves felt, crushing the pillars in the stopes, destroying the ribs above and below the drives, and in some cases even affecting the shaft pillars.

In order to arrest this untoward movement, which at one time threatened the loss of the main thoroughfare of some of the mines, a system of sand filling has been adopted. By this system, abandoned stopes and other working places in the mines are filled with sand, taken from the residue-dumps or run in direct from the current reduction operations.

The method employed in the case of the old residue dumps is to mix the sand with sufficient water to cause it to flow down the pipes in the shaft and to be discharged in the stopes prepared for its reception. Where current and sand residues are used, these are pumped as pulp, from the sand-treatment vats, and are thickened in cone classifiers before delivery underground. Underground, the pulp is conducted by wooden launders to the stope to be filled. Barricades are used to keep the sand in place, but it drains well, and soon packs solid enough to bear the weight of a man. The effluent water is pumped back to the surface, and this charge is one of the chief items of expense. Another is the renewal of the pipes used to convey the sand down the shafts. The sand is extraordinarily abrasive, and the life of the pipes is very short. The cost of the process, however, is balanced to some extent by the increased ore reserves, due to the advantage of not having to leave pillars in the stopes, coupled with the saving of the cost of cutting them,

At first it was feared that cyanide remaining in the sands would be dangerous to the mine workers, but a little research has eliminated this

Village Main Reef, Ferreira Deep, Robinson, and Simmer and Jack mines, and there is little doubt that it will be adopted universally.



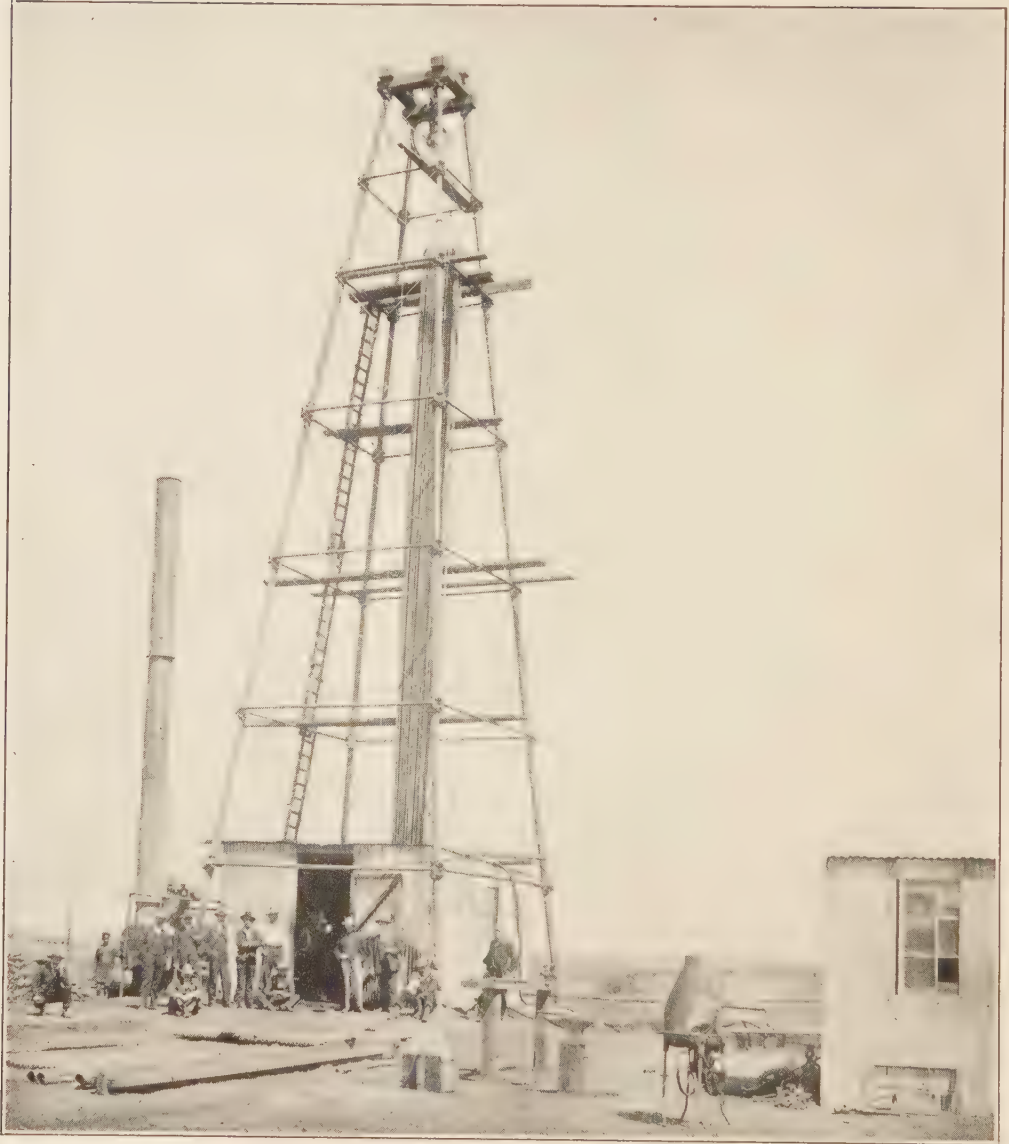
ERECTING STEEL HEAD GEAR, CINDERELLA DEEP GOLD MINE, WITWATERSRAND
Imperial rivetting hammers, Ingersoll-Rand Co.

source of danger. The percentage of moisture in the pulp, as it comes from the thickening cones, is 12 per cent. It consists of water containing up to 0.02 per cent of cyanide. By adding a 5 per cent solution of permanganate of potash, or of chloride of lime, it is found that the percentage of cyanide in the moisture of the sands can be reduced to less than 0.0025. The effluent water from the sand packs underground shows no trace of cyanide, and no hydrocyanic acid has been found in the air of the stopes which are being filled.

The filling of the worked out stopes will also assist ventilation, since it will prevent the dissipation of the fresh air current. The system is already in use at the Village Deep,

VENTILATION

The subject of ventilation in metaliferous mines is attracting attention at present all over the world where mining is conducted on a large scale. Wherever drilling machines are employed in stoping work in dry ground, the atmosphere is charged with dust. Such fine siliceous dust is extremely injurious to the miners and causes them to become affected with phthisis and other chest complaints. The mortality rate among miners on the Rand is high, and steps are being taken to improve the sanitary conditions of the mines by instituting mechanical ventilation along the lines practiced in collieries and by spraying the stopes with fine jets of water. In the early days of the Rand, and



A SULLIVAN HEAVY DUTY DIAMOND DRILLING OUTFIT IN OPERATION ON THE RAND

indeed, up to quite late, it was not found necessary to employ any artificial system of ventilation, the numerous shafts and outlets to the surface of the outcrop mines sufficing to maintain an ample supply of fresh air. But with deeper levels (the Village Deep Mine is already working at a vertical depth of 4,000 feet), fewer communications with the surface, and a higher rock temperature, artificial

ventilation must be employed. Mr. Stuart Martin is of the opinion that it will be impossible to work the deep levels economically without carefully thought out schemes of ventilation, and that for the success of these it will be necessary to have shafts with small frictional resistance and large air-space, and to carry the air current through special ventilating roads.

The quantity of pure air to be sup-

plied per minute, per man employed underground, is fixed by law at 70 cubic feet. This being a standard difficult to enforce, the South African Mining Regulations Commission, whose report was published in 1910, propose as a substitute the quality standard of a maximum of 20 parts by volume of carbon dioxide per 10,000 parts of air. Of this 4 parts is an allowance for the CO_2 produced by the burning of candles, and there is a further allowance of 5 parts for the CO_2 possibly given off from the country rock, leaving 8 parts per 10,000 as a legal limit for the noxious CO_2 due to the vitiation of the air by blasting, human emanations, etc. Under the proposed regulations, provision is to be made on each mine for a permanent upcast and a permanent downcast shaft by the use of ventilating fans or otherwise. The current of fresh air so produced is to be split by regulating doors at every level where work is carried on, in proportion to its requirements. The course of pure supply and foul return are to be kept distinct by bratticing, and short circuiting is to be prevented by stopping-off disused drives, stopes, etc.

The ventilation problem has been seriously attacked on the Rand, and already ventilating fans ranging in capacity from 50,000 cubic feet per minute, at 1-inch water gauge, to 250,000 cubic feet at 4-inches water gauge, have been installed at the East Rand Proprietary mines, at the Simmer Deep, at Village Deep, at the Langlaagte Royal Shaft of the Crown Mines, and at several other mines of the Eckstein-Rand mines group. In splitting the air current, the numerous dikes of igneous rock that traverse the Witwatersrand mines in a north and south direction across the strike, can be made to serve as natural brattices, since they cut up the mines into airtight compartments.

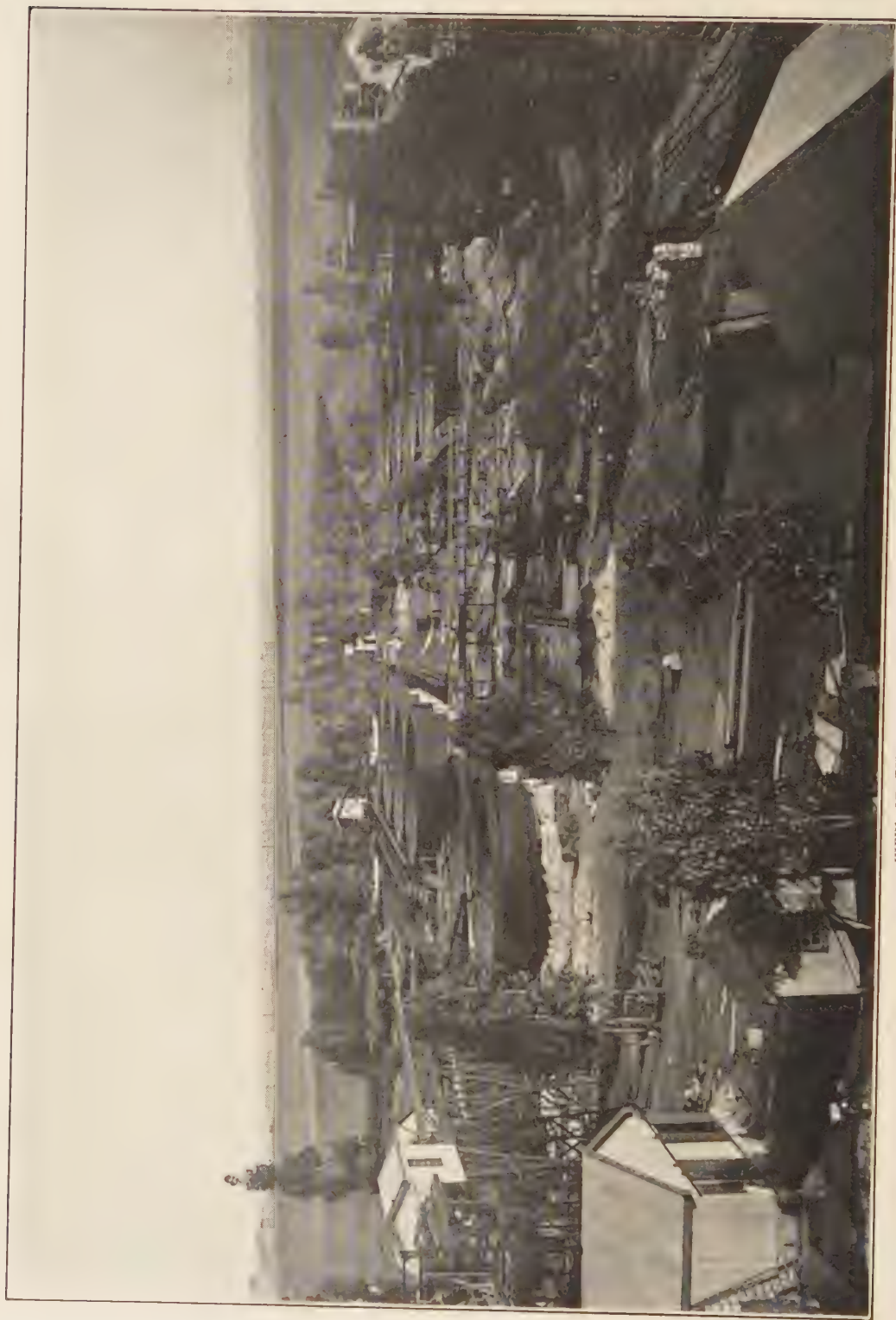
The level which penetrates these dikes must be permanently closed, or, if needed for tramming purposes, closed by double swinging doors.

The ventilation of the mines is hampered by the small air space and large frictional resistance of the rectangular timbered shafts at present in use on the Rand. For this reason, many of the deeper shafts of the future will, no doubt, be of circular section, with either brick or concrete lining, as is the common practice in the collieries in England.

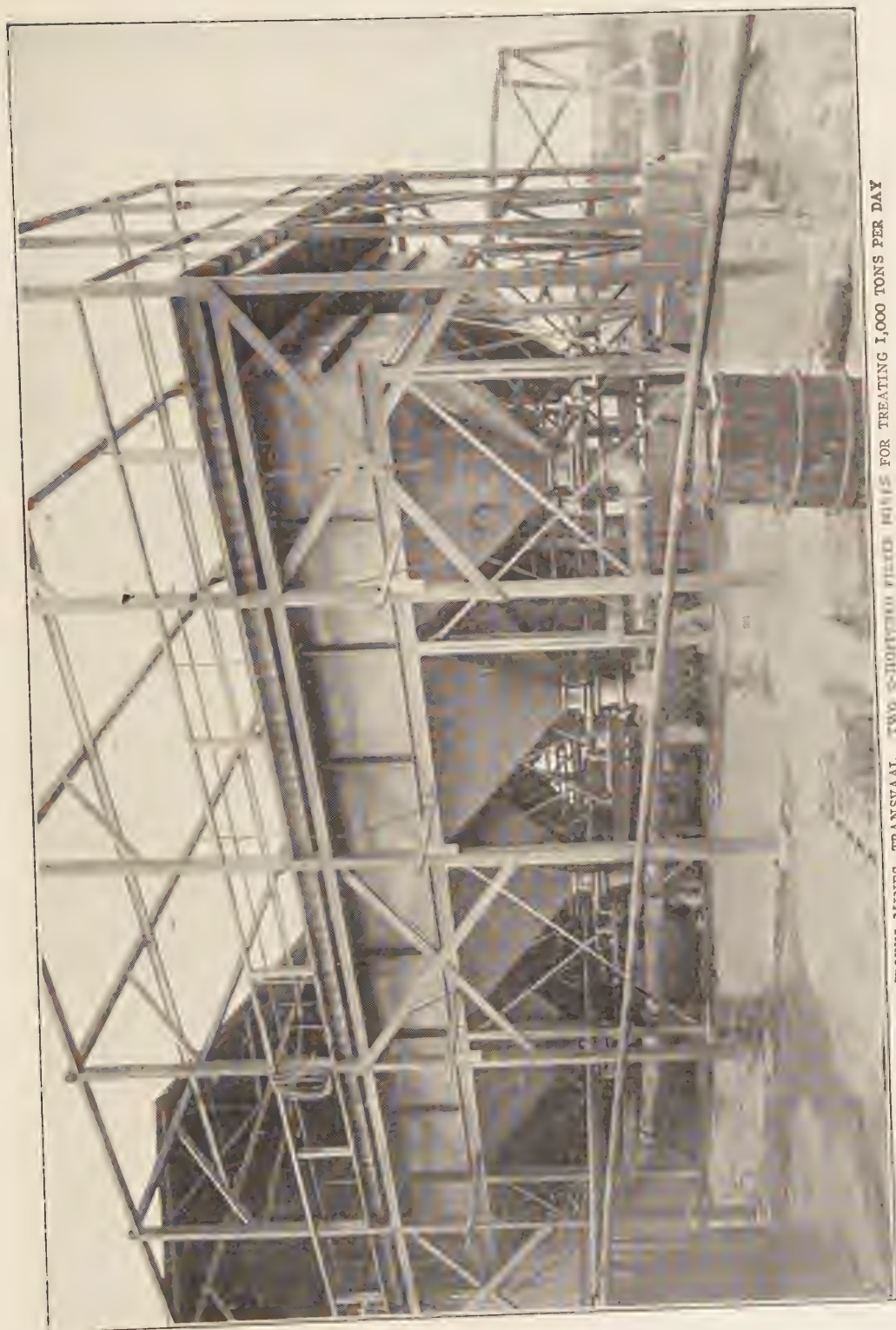
Main levels and underground inclined shafts will also be driven in the footwall. These will serve as intakes for the air current and, being in solid ground, will reduce to a minimum the loss of air by short circuiting. Since these main ventilating roads, instead of following the regular course of the reef plane, are driven straight, they will be admirably adapted for cheap mechanical transport.

CYANIDING

The bulk of the gold obtained on the Rand is saved by the cyanide process, which has been largely perfected in South Africa. In the best plants, the sand and slime are separated in a mill product by feeding the mill pulp into a cone-shaped collector or diaphragm-cone. These differ from previous classifiers in being run nearly filled with settled solids instead of fluid pulp. The sand is drawn off as thickened pulp from the bottom, while the slime flows over at the periphery. The sand, after passing through a secondary washing cone, which it leaves in the form of an eminently leachable product with less than 1 per cent of slime and about 30 per cent of moisture, is freed from most of its remaining water on a Caldecott filter table. This is a slowly rotating horizontal vacuum filter. After almost completing a journey around the table, the sand,



VIEW OF THE CYANIDE WORKS, MODDER B. MILL



BUTTERS FILTER, CROWN MINES, TRANSVAAL. TWO 8-HOUR SHIFT FILLS FOR TREATING 1,000 TONS PER DAY

containing less than 12 per cent moisture, is scraped off by a fixed inclined plow and falls into a launder, where it mixes with a stream of cyanide solution. It is raised by a sludge pump and fed by a Butters distributor into a vat already filled with cyanide solution, the overflow being returned to the launder to complete the circuit. By this continuous method of sand collection, the solution of the gold is commenced within half an hour of the crushing of the ore. The treatment is either completed in the collecting vat, or the charge is transferred to a second vat for final treatment. The process is accelerated and assisted by

which enable the rich cyanide solution to be rapidly drawn off from the slime residue and sent as a clear liquid to the extractor boxes. The Butters vacuum filter is now in successful operation at the Crown Mines and will be installed at the Bantjes, the New Modderfontein, the Robinson and the Modder B. Mines. The precipitation of the gold was effected in the original MacArthur Forrest process by zinc shavings, and this method is still preferred for the rich solutions—but for weak solutions, such as are obtained in the treatment of slimes, the Merrill patent, in which zinc dust is employed as a precipitant, is con-



SHUTTLE BELT CONVEYOR OVER MILL BINS AT MODDER B. MINES, DISTRIBUTING ORE THROUGHOUT THE LENGTH OF THE MILL

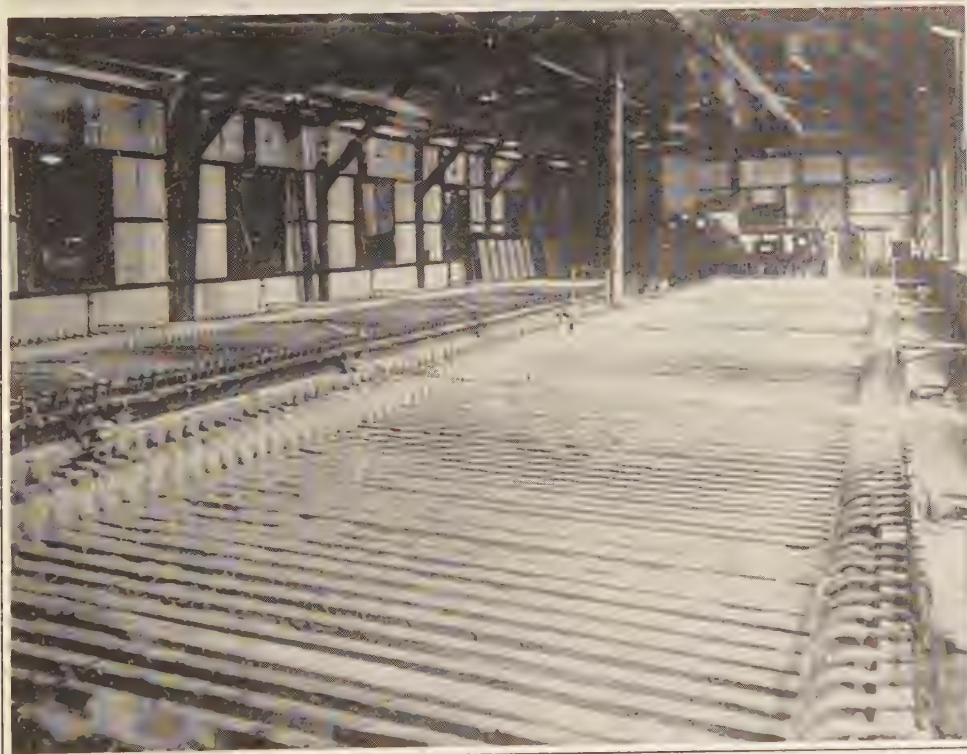
the use of the vacuum pump, by means of which the moisture remaining in the sand after each draining can be reduced to 9 per cent.

Slime treatment has been much facilitated by the introduction of air agitation tanks and vacuum filters,

considered to be superior to the lead-zinc couple, and this method is now being used at the Village Deep and will be adopted by other mines.

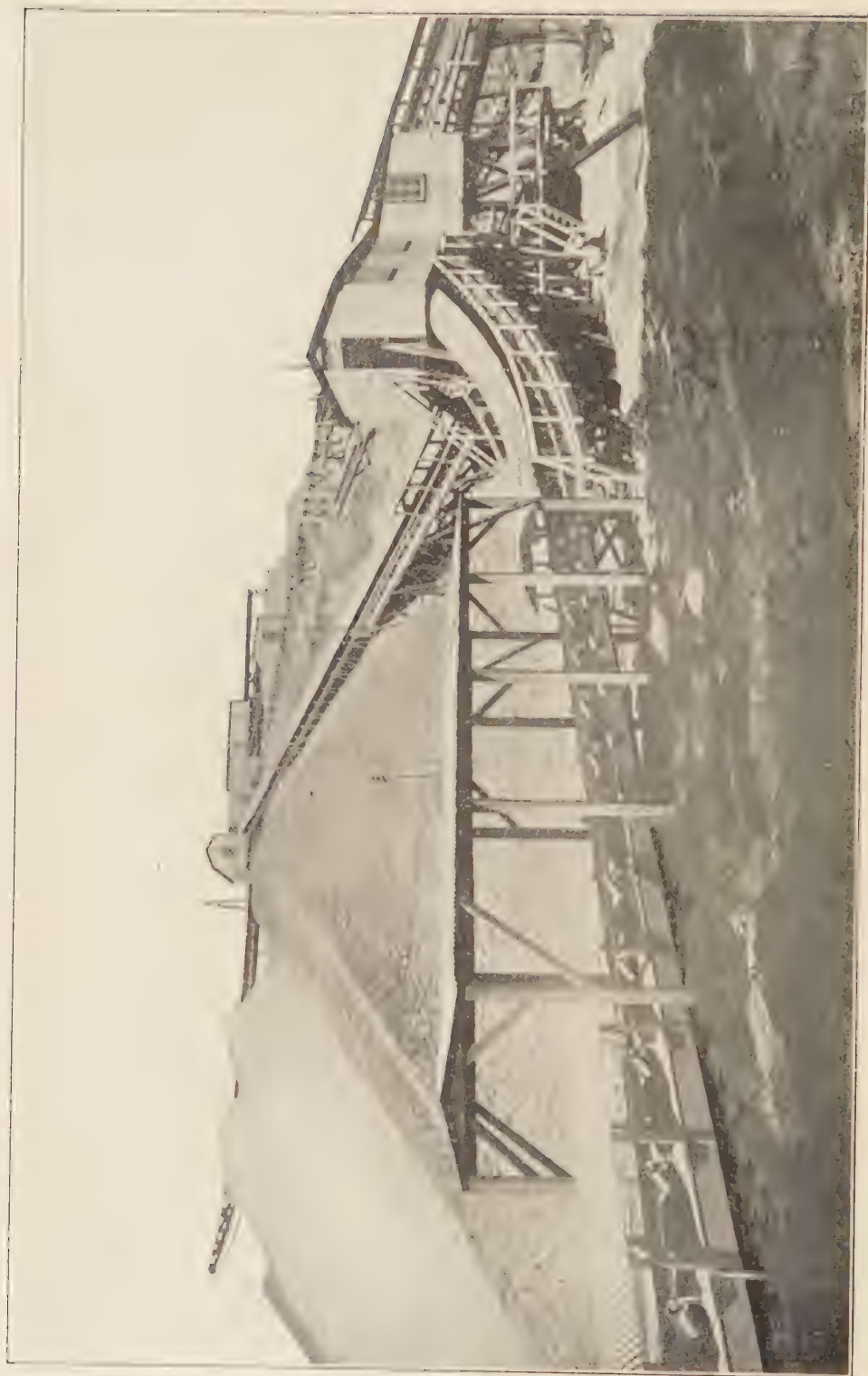
MILLING

Two important modifications of stamp milling have been made on the



BUTTERS FILTERS AT RAND GOLD MINES

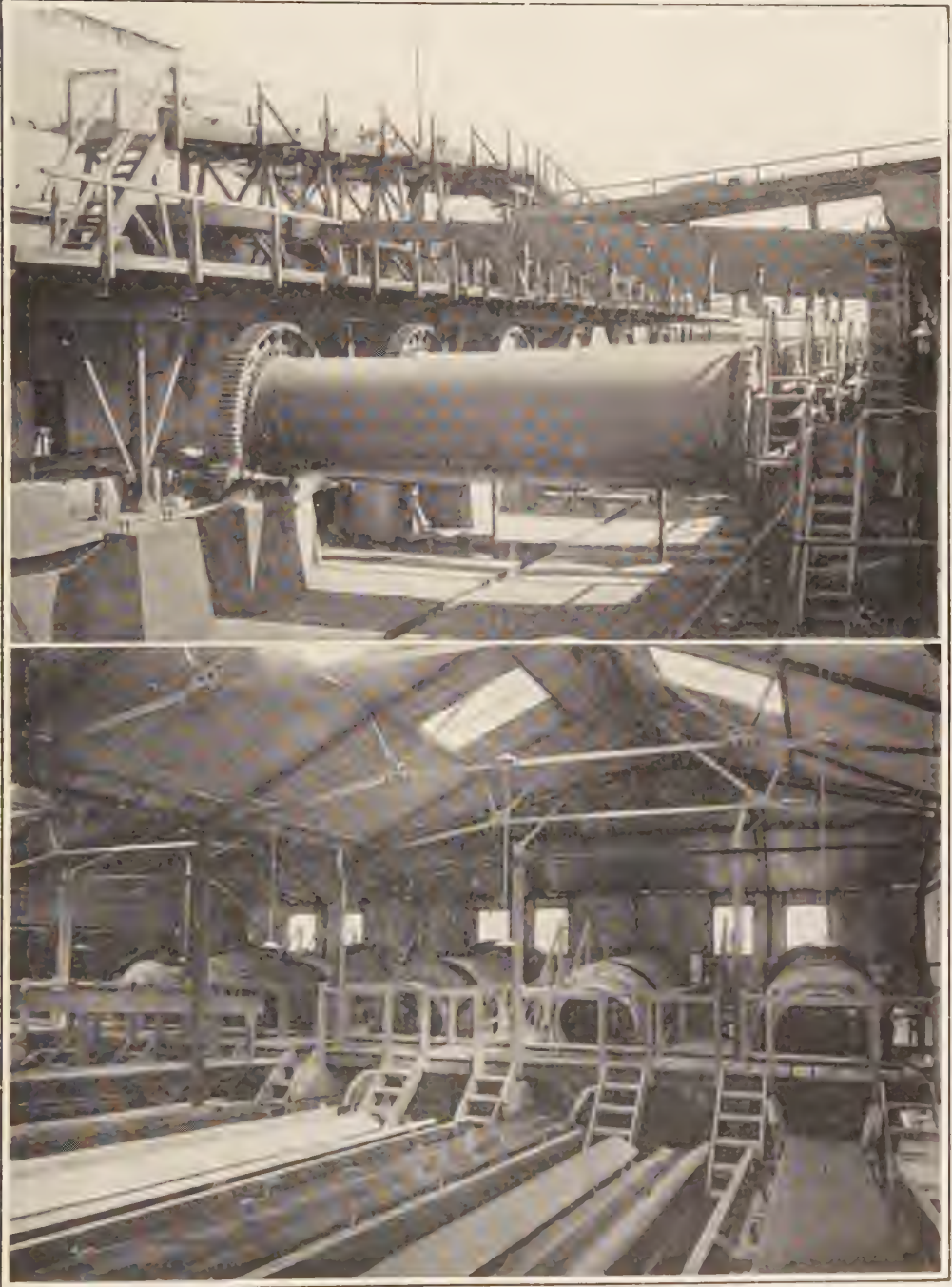
Above, Robinson Gold Mining Co., treating 1,500 tons daily. Below, New Modderfontein Gold Mining Co.,
1,000 tons slime per day



JEFFREY BELT CONVEYOR AND TAILING'S STACKER AT A SOUTH AFRICAN MINE

Rand. The effective range of the stamp battery is found to be between $1\frac{3}{4}$ inches and $\frac{1}{4}$ inch in diameter for the crushed ore fed into the mor-

tar. Stone larger than $1\frac{3}{4}$ inches or smaller than $\frac{1}{4}$ inch diameter fed to the stamps results in higher crushing costs. It follows, therefore, that the



ABOVE, TUBE MILLS AND DEWATERING CONES. BELOW, SORTING AND WASHING TROMMELS AND SORTING BELTS, BRAKPAN MINES

stamps should be retained for coarse crushing only. When so used, there is less use for amalgamation plates and the plate area has been reduced while some metallurgists advocate the total abolition of the amalgamation process.

In some of the new mills the amalgamating tables are assembled, together with the precipitating boxes for the cyanide solution, in a reduction house in which the tube mill and enriched cyanide solutions are pumped. This enables an increase to be made in the running time, since the stamps have not to be hung up while the plates are being dressed.

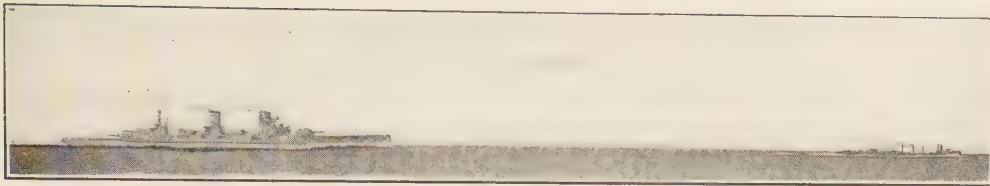
Stamp duty has been enormously increased by the coarse crushing practised and by "by-passing" the "fines" direct from the rock-breakers to the tube-mills. The weight of individual stamps has also been increased, until with the 2000-pound stamp of the City Deep mill the economic limit of the cam-lifter gravitation stamp appears to have been reached.

CONCLUSION

The Rand mines have produced over a billion dollars' worth of gold in the past 26 years and are now yielding nearly two-hundred million dollars worth annually. The grade of ore mined is diminishing while the annual tonnage crushed is increased. The net result is an augmentation of

the net profit. It costs \$4.30 per ton to produce the gold and the average value of the ore mined is about \$6.80 per ton. Mining profits average, therefore, about \$2.50 per ton. The influences of increasing tonnage and diminishing ore values upon the Rand afford interesting studies. There is no doubt regarding the continuation of the gold-bearing bankets at depth. At a depth of 7,000 feet the rock temperature is about 97½ F. and, with efficient ventilation, the workings could be kept cool at that level. Deep mining, consequently, will be controlled only by the gold content of the ore. Should the gold-bearing formations be worked to a vertical depth of 6,000 feet, and estimating on an average annual return of \$200,000,000 gold, it will be possible for the industry to be carried on extensively for the next thirty-five years. It is probable, however, that some of the prospecting operations now being carried on both in the Eastern and Western ends of the banket may result in opening up new gold-bearing ground that will prolong the life of the industry. But there is no doubt that the South African mines will continue to yield large quantities of gold for a period of at least thirty years. In other words, the total gold production of the Transvaal mines in the past will be exceeded by their production in the next thirty years.





THE BATTLE-CRUISER

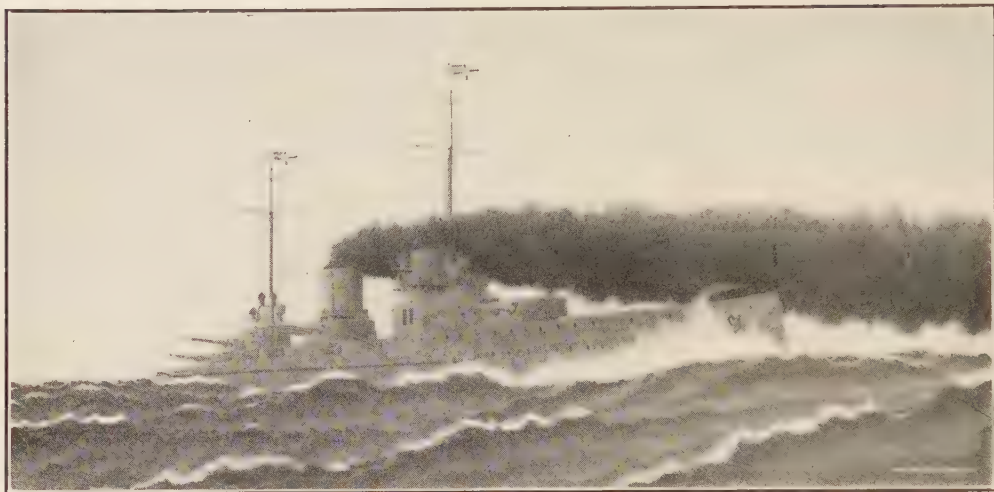
By Burnell Poole

Special pertinence attaches to Mr. Poole's article because of two matters of current interest. One is the visit to American waters of the German fleet, including one of the newest battle cruisers. The other is the active Congressional debate over the increase of the United States Navy. The data here given should be a strong influence toward proving the need for an adequate strengthening of American sea power.—THE EDITORS.

WE are all more or less familiar with the great transatlantic liners of the present day—the swift and enormously powerful “Mauretania” and “Lusitania” and the gigantic “Olympic” and ill-fated “Titanic”—yet, probably few of us are acquainted with the fact that there are in existence ships with even more remarkable qualities than are possessed by these leviathans of the deep. I refer to that type of ship which is now commonly called the “Battle-cruiser.” The name is almost self-explanatory—“Battle-cruiser”—a cruiser able to take a position in the line of battle. We owe the introduction of this type of warship into the world's navies to that nation which today possesses the most powerful navy the world has ever known—Great Britain. Having developed the first all-big-gun battleship, the “Dreadnought,” this nation turned its attention to the construction of an all-big-gun cruiser, and with such astonishing results that the latest ships of this type are undoubtedly the most remarkable that have ever been built. Although England was the first nation to equip her navy with ships of the “battle-cruiser” type, she has been closely followed by

other nations, particularly her greatest rival, Germany. Japan has already entered the lists, with Russia about to do so and the other great naval powers watching the rapid development of this type of fighting ship with tremendous interest. Little do we realize on this side of the Atlantic the intense rivalry which exists at the present time between Great Britain and Germany as regards their naval armaments, and probably in no way is this rivalry keener or better exemplified than in “battle-cruiser” race which is now going on between these powers. To possess the fastest all-big-gun warship in the world seems to be the ultimate desire of each of these two great nations.

Without going into great detail, let us see what has been accomplished with this type of warship by England and Germany up to the present time. In doing this, however, it should be borne in mind that these ships throughout their entire history have been more or less veiled in secrecy by their respective governments, and practically no official information whatever concerning them has ever been given out. Germany especially is surprisingly successful



GERMANY'S FAMOUS BATTLE-CRUISER "MOLTKE" STRIPPED FOR ACTION

in withholding the details of her naval construction from the outside world, and it is almost impossible to obtain any authentic information pertaining to her ships even up to the time of their commissioning in the High Sea Fleet. Much comment appears in the British and German scientific press as to the probable specifications according to which these ships are being constructed, and this information in most cases is conceded by naval experts to be substantially correct. Consequently any figures which may appear in this article cannot be taken as absolutely correct, but they do nevertheless represent those figures which are generally accepted by naval authorities.

A battle-cruiser may be described as a ship of great size and speed, comparatively lightly armored, but possessing the battleship's armament of heavy guns. In other words, in the construction of the battle-cruiser defensive strength is sacrificed for greater boiler and engine rooms, and the hull is made correspondingly large to allow greater space for fuel storage so that the steaming radius may not be sacrificed at the same time, as coal consumption on this

type of ship is extremely high. Naturally these vessels are an enormously expensive investment, as upkeep and depreciation are very high in addition to their large first cost.

Primarily the function of the battle-cruiser is to protect its nation's commerce in time of war by driving off the seas the commerce destroyers of the hostile nation, and furthermore in case of a general engagement the battle-cruiser will take her place in the first line of battle with the better protected but no more powerful battleships. It requires but a slight stretch of the imagination to foresee the effect on the enemy of having a number of these powerful vessels at large upon the high seas. With their great speed and powerful weapons, they can roam the seas unmolested ready for any emergency and preying upon the enemy's commerce. Even the heretofore much dreaded torpedo-boat-destroyers hold no terror for the battle-cruiser, for at sea the sustained speed of the cruiser will be higher than that of any present-day ocean-going destroyer. Hence in case she is attacked by a flotilla of destroyers, she can look the situation over and decide whether

it is best to fight or run, knowing that if the latter course is resorted to she can in the long run in the open sea easily outdistance any of the hostile destroyers. Should the battle-cruiser sight the enemy's battleship fleet it is a very simple matter for her to hover just out of range, ascertain the number of ships and strength of the enemy, and then with a burst of speed get in touch with her own battleship fleet and report to the flagship.

The following list will show the rapid development of the British battle-cruiser up to the present time:—

	Tons	Length ft.	Speed	Horse- power	Main armament	Year laid down
Indomitable } Invincible } Inflexible }	17,250	560	25	41,000	8 12 in.	1906
Indefatigable } New Zealand }	19,200	578	26	45,000	8 12 in.	1909
Australia }	18,750	555	26	44,000	8 12 in.	1910
Princess Royal } Lion }	26,360	690	28	70,000	8 13.5 in.	1909
Queen Mary...	28,850	725	28	75,000	8 13.5 in.	1911
Tiger (?)	32,000 (?)	(?)	(?)	100,000 (?)	8 13.5 in.	1912

The cruisers "New Zealand" and "Australia" were presented to the Royal navy by the respective colonies bearing those names.

The German battle-cruisers have been fewer in number and their general features are as follows:—

	Tons	Length ft.	Speed	Horse- power	Main armament	Year laid down
Von der Tann..	19,000	558	25	45,000	8 11 in.	1907
Moltke } Goeben }	23,000	610	25.5	50,000	10 11 in.	1909
"J" }						1910
"K"	?	?	?	90,000 (?)	10 12.2 in. or 8 14 in.	1911

Japan at present has the following battle-cruisers either building or ordered:—

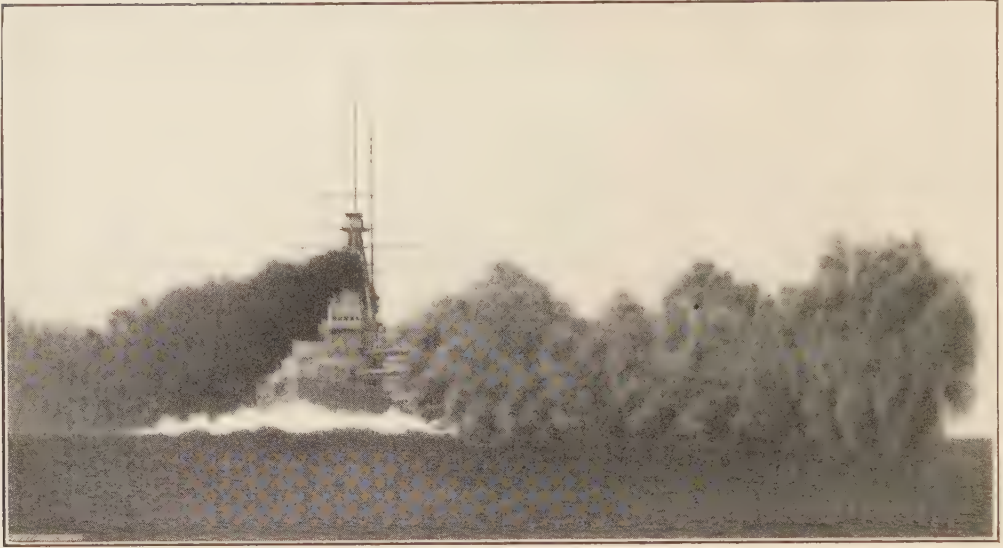
	Tons	Length ft.	Speed	Horse- power	Main armament	Year laid down
Kongo } Haruna } Kirishima }	27,500	(?)	25	64,000	8 13.5 in.	1911
Hiyei }						1911
						1912

The "Kongo" is being built by Vickers, England, and was laid down in January, 1911. She will probably fly the Mikado's flag some time during 1914. The other three cruisers will be built in Japan. The "Hiyei" is being built at the Yokosuka yard and was laid down in August, 1911. The "Haruna" is building at Kobe, and the "Kirishima" has been ordered. These ships will hardly be ready before the latter part of 1915.

It is understood that Russia will lay down four large battle-cruisers this year on the stocks which have re-

cently been vacated by the launchings of her four 23,000-ton battleships. The Russian cruisers will displace about 28,000 tons and will be armed with 14-inch weapons, the designed speed being between 25 and 26 knots. Naval construction in Russia

is extremely costly and slow, so that these ships will probably not be completed until 1916.



THE BRITISH BATTLE-CRUISER "LION" FIRING A BROADSIDE SALVO OF EIGHT 13.5-INCH GUNS
The "Lion" is the fastest and most powerful vessel of her class in the world.

A great many conflicting reports have appeared as to the actual performances during acceptance trials of those battle-cruisers which have already been completed. The race so far has been confined to England and Germany, and it has been very interesting. Each succeeding triumph of one nation's battle-cruiser over that of the other is received with great satisfaction throughout the nation possessing the record-breaking ship. Just where this struggle will end and what marvellous ships it will lead to is a matter of conjecture. It is, however, fairly safe to predict the launch within the next five years of enormous cruisers of 40,000-tons displacement and 40-knots speed, mounting 16-inch weapons. A brief history of battle-cruiser speed performances to date will give some idea of the results that have already been accomplished.

Naturally, the British "Indomitables," laid down in 1906 and completed in 1908, were the first battle-cruisers to go out on trial. Reports as to the speeds of these cruisers vary from 26 to 28 knots; probably the mean, 27, is very near the correct

figure. These ships immediately became the fastest cruisers in the world and their appearance on the high seas at once rendered obsolete the contemporary cruisers of all other nations. Honors remained with England until the appearance of the German "Von der Tann." This mysterious ship, for such she surely had been, at once appropriated that much-sought-for title—the fastest ship in the world. Developing nearly 80,000 horse power, she had a high run of 28.14 knots over a six-mile course, and Germany had beaten England at her own game. England, however, was content to await the trials of her new "Indefatigable." The first trials of this ship were conducted with only 75 per cent of her boilers delivering steam to the turbines, and under these conditions she easily made 27 knots and on a subsequent full-power trial she is reported to have made 29 knots, so that the world's battle-cruiser record was brought back to Great Britain. England's triumph was not for long, for when the German cruiser "Moltke" returned from her trials the world's high-speed-

cruiser record had again been broken and Germany once more possessed the fastest cruiser in the world. The "Moltke" had attained the remarkable speed of 29.5 knots, and it was reported that her engines had developed a maximum of 88,000 horse power. This was conceded in England to be an extraordinary performance, and to reflect much credit upon German naval construction and particularly upon the firm of Blohm & Voss, Hamburg, the builders of the "Moltke." Incidentally this ship is making a visit to the United States at the present time, and at the request of the German Emperor she will attempt to break the transatlantic record now held by the Cunard flyer "Mauretania." England now pinned her hopes on the new "Lion," and she was not disappointed; for on January 9, 1912, this remarkable ship travelled through the water at the phenomenal rate of 31.5 nautical miles per hour, and great was the rejoicing in England at having beaten the Kaiser's "Moltke." Details of the trial were not divulged, except to state that the "Lion's" boilers and

turbines worked to the satisfaction of both the navy men and builders. Weather conditions were very severe at the time of the trial, and moreover coal was used throughout instead of oil, so that under ideal conditions, using oil, it is thought that the "Lion" can do about 33 knots. With the "Princess Royal" soon to go on trial and the "Queen Mary" coming along, it is difficult to see any German ships in sight capable of wresting the speed laurels from England in the near future. The German "Goeben" is practically completed, but it is understood that she is very similar to the "Moltke" and it is doubtful if she can better her sister-ship's fine record by very much. The "J" has as yet not been launched, and presumably it is an improved "Goeben," but whether or not it will be able to better the wonderful records of the English ships remains to be seen. The "K" will certainly be a remarkable ship, and much may be expected of it, but by the time it is completed England probably will have completed her "Tiger"—and thus the game goes on.



AN ANALYSIS OF PRACTICAL TIME-MOTION STUDIES

By George H. Shepard

Time study as a basis for scientific rate-fixing is widely known as an institution, but the literature of the day seems to be richer in controversy over the theory than in definition of the practice. Mr. Shepard goes into the subject with practical analytical detail, and his article will be found a specific and substantial answer to many recent inquiries for working data on this subject.—THE EDITORS.

SIMPLY to time the performance of a task with a stopwatch, or even with an ordinary watch, is easy but does not produce the desired results, which are two:—

First, the determination of the best way to do the task; that is, the standardization of the operation; and

Second, the determination of the standard time for the performance of the standard task.

In order to accomplish these purposes, the time-motion-study must be resolved into the following components:

maintaining elements of better, quicker, and more economical ones, wherever possible.

Fourth, the synthesis of the retained elements into a standardized task, and of the elemental times into a standard time.

Fifth, the detection and correction of errors in the results by the application of checks and by practical test.

As an illustration is given an example of a workman operating at the same time a rotary furnace, and a machine (a bolt-header) upsetting hot stock from this furnace.

TABLE I.

No.	Right Hand	Left Hand	Right Foot	Machine (Bolt Header)	Time per Piece (minutes)
1	Picking up one piece of stock and putting it into the furnace	Holding dies open	Idle	Idle	.006
2	Taking one piece of stock from furnace to machine	Same	Idle	Idle	.003
3	Placing stock in dies	Same	Idle	Idle	.002
4	Idle	Holding operating clutch in gear	Idle	Striking two blows	.060
5	Idle	Opening dies	Idle	Idle	.003
6	Idle	Idle	Pumping furnace around 6 holes once in 6 pieces	Idle	.010
Total					.084

First, an analysis of the task into its elements, with a determination of the standard times for each.

Second, the elimination of all unnecessary, or waste, elements.

Third, the substitution for the re-

This case is chosen as an illustration because it is mechanically very simple, and at the same time exemplifies all the principles of time-motion-study.

Details are given in Tables 1 and 2.

As to the making of the study of Table I, no one observer can handle stop watch, pencil, and paper fast enough to record such brief elements continuously. To make such a study it is therefore necessary that the operation should be a cycle repeated many times. The observer can then time and record as many elements out of each cycle as his own speed will allow, until he has got records of them all.

The error due to stopping and starting the watch is considerable in such brief times. It is therefore necessary that the total time of the cycle should be determined independently. This is best done by timing so long a series of cycles that the initial and final errors are immaterial. The elemental times as determined by the stop watch are then used merely to divide the total, separately observed, into the proper proportions.

For example, in the illustration above, the average of the stop-watch times for the first operation might be .0054 minutes, and the sum of stop-watch times for all the operations, .075. Then the total time, separately determined, for the whole cycle of Table No. 1 being .084, the corrected time for the first operation is

$$.0054 \times \frac{.084}{.075} = .006 +$$

In order to reduce the effect of the error due to starting and stopping the watch, and to allow for variations in the real time of performing the elemental operations, it is necessary to take and to average a considerable number of observations of each elemental operation. This serves another purpose which will be noted later.

The stop-watch error is a matter of chance, instead of being proportionate to the total time; and the above method is therefore incorrect

in theory; but it affects most seriously the shortest intervals of time; and, as no appreciable economy is possible by shortening these operations, the result is close enough for a working approximation.

Thus, in Table I, the time of .002 minute for placing stock in dies is probably grossly inaccurate; but, in any case, no material economy can be made by reducing this time; while the time of .06 minute for the fourth operation, that in which the stock is upset, should be about right; and, as will be shown below, in this case the greatest gain was made by improving this operation.

A study like that of Table I is possible only when the operations are repeated in short cycles. For example, the making of a complicated sand mould, even if it could be standardized as to elemental motions into a definite cycle, would be so long that the study of cycles enough to produce a table like Table I would be impracticable. Also, many operations are necessary, beside the main cycle of handling; and these do not appear in a study of the type of Table I. It is therefore necessary, in all cases, to make a study of a different type, which does not analyze so finely; but which covers all operations during a considerable time. For the job of Table I such a study would be of the form shown in Table II.

A cycle of one box of stock was completed at Operation 12. The study should be carried through two or three such cycles, at least. The total time for three cycles, by stop watch, may be 95.5 minutes. The stop watch should always give too short a time, because the time taken to operate and to read the watch, subtracts from the correct time. The total time of a study of the type of Table II should therefore be taken independently, and preferably by a standard watch,

because it is much more accurate than the ordinary stop watch for measuring considerable intervals. The total time by standard watch may be 101.8 minutes.

The error of the stop watch is then

$$\frac{101.8 - 95.5}{101.8} = 6.2 \text{ per cent}$$

which will be corrected later.

most perfectly under the control of the engineer, and by causing the machine to work properly a valuable economy can often be made. This line of investigation has received very great attention in the field of cutting metals, in which F. W. Taylor's researches are too famous to require further mention. I wish here

TABLE II

No.	Operation	Time (minutes)
1	Lifting one box of stock from floor and dumping stock onto tray of furnace	.05
2	Adjusting oil-valve of furnace.....	.03
3	Loading furnace with stock.....	.11
4	Waiting for heat.....	.15
5	Upsetting 84 pieces of stock.....	7.50
6	Hauling upset stock from under header.....	.20
7	Placing empty box under header.....	.04
8	Upsetting 91 pieces of stock.....	7.55
9	Receiving instructions from foreman.....	.08
10	Upsetting 150 pieces of stock.....	12.25
11	Visiting toilet	3.00
12	Getting drink	1.03
13	Lifting one box of stock from floor and dumping stock onto tray of furnace	.06
14	Loading furnace with stock.....	.09
15	Waiting for heat.....	.20

Table II gives directly the total for Table I, since we have in Operations 5, 8, and 10, 325 pieces of stock upset in 27.3 minutes, giving .084 minutes per piece.

To get this total time per cycle of Table I, and to acquire a general familiarity with the work, it is advantageous to make first the study of Table II.

Looking through Table I for unnecessary, or waste, elements, one is found in the fourth operation, in that the header upset the stock always by the first blow. The use of two blows, one of which was entirely wasted, had never been corrected by the workman or any of his superiors, but was shown at once by the time-motion study.

In general the proper speed and number of motions of machines can be much more accurately determined than can those of men. Operations in which time and speed are determined by a machine are therefore al-

merely to point out that possibilities of similar betterment exist, wherever any kind of machine is used.

Looking through Table I with a view to the improvement of necessary operations, this is found to be possible by making the first and sixth operations simultaneous and causing the workman to pump the furnace-top around one hole only for each piece of stock, which he does with the right foot while at the same time, with the tongs in his right hand, he picks up one piece of stock from the tray of the furnace and places it in the furnace to be heated. This reduces the number of elements of the cycle of handling to five.

The preceding is typical of a large class of wastes which consist in causing one motion to wait for another, when the two might be made at the same time. Wastes of this kind escape the eye in general observation, but careful study with the stop watch shows them at once.

The improvement of necessary operations is an essential feature of time-motion-study work. On this point Gilbreth says:

It is as well to recognize, first as last, that real progress from the best present method to the standard method can never be made solely by elimination. . . . Elimination is often an admirable makeshift, but the only real progress comes through a reconstruction of the operation, building it up of standard units, or elements.

This reconstruction may be so radical as to produce an entirely new operation in place of the old, as in Gilbreth's famous work in bricklaying. An example of such radical reconstruction in this case would have been the design and construction of an automatic header, so that the workman would merely have fed it hot stock, while it would have operated continuously and would have delivered the upset stock for the next operation.

Gilbreth lists forty-two variables, many of them peculiar to the individual workman, which affect decision as to the best method for every elemental motion. The ordinary problem of the engineer, however, is not to set separate standards for each man, but to set average standards for a whole shop. Also the time necessary for rest is very seldom accurately known, and the final standard time is rounded, for shop convenience, to the nearest tenth of an hour.

The efficiency engineer should always bear in mind a composite of the variables that affect every motion, just as the designing engineer should always have in mind a composite of all requirements, physical, chemical, mechanical, and commercial, of every machine part; but to give separate consideration to all the forty-two variables with reference to every motion is a refinement comparable to designing ordinary machine members to the ten-thousandth of an inch.

Examination of both Table I and Table II should also be made for another common class of wastes, those due to wilful loitering on the part of the workman.

When a man purposely shirks, his times for the performance of elemental operations will vary widely; consequently such shirking would be detected by comparing the different observations of times of single elemental operations, from which the results of Table I were averaged. Similarly, from Table II, the average times for upsetting a single piece of stock are

Operation 5 089 minutes

Operation 8 083 minutes

Operation 10 082 minutes

which agree as closely as could be expected, and indicate that the man was working faithfully.

When a study has been made on a slow workman, a correction may sometimes be made by multiplying the standard time resulting directly from the study, by the man's observed efficiency in comparison with existing standards; but this is rarely useful, unless such efficiency, on standard tasks under standard conditions, is at least 80 per cent; and, if necessary, a skilful and fast man should be put on the job for the sole purpose of making a time-motion-study of his work. Conditions should always be standardized, before time-motion-studies are made; but the latter must be made as the means of standardizing the operation. Hence the workman on whom the first time-motion-study of a job is made, is always doing an unstandardized operation; and it is to be expected that his efficiency, as compared with the standard developed later, will be low from this cause, if from no other.

Where an apparent standard time is multiplied by the worker's observed efficiency to get the result,

TABLE III

Right Hand	Left Hand	Right Foot	Machine (Bolt Header)	Time per Piece (minutes)
Picking up one piece of stock and putting it into furnace	Holding dies open	Pumping furnace around one hole	Idle	.010
Taking one piece of stock from furnace to machine	Holding dies open	Idle	Idle	.003
Placing stock in dies	Same	Idle	Idle	.002
Idle	Holding operating clutch in gear	Idle	Striking one blow	.030
Idle	Opening dies	Idle	Idle	.003
			Total	.048

care should be taken that standards which determine his efficiency refer to the same class of work as that on which the study was made. For example, the studies of Tables I and II were made in a shop in which standard times had been in force for only a short time, during which the workman in question had made an efficiency of only about 60 per cent. He had been employed, however, outside his regular line of work. These studies were the first observations that were made of him on his regular work, and the standard time directly resulting proved to be short enough.

A competent engineer can cut out wastes from almost any kind of work, and he can also usually improve necessary operations of unskilled workmen and machine operators; but to do the latter to approximate perfection in a skilled trade requires a man who is himself a skilled workman thereat. For example, consultation at least, with an expert machinist is required in order to make the best improvement of necessary operations, and to set standards from time-motion-studies, in a machine shop. By "an expert" is meant one who is expert when judged by the standards of scientific management. An expert machinist, for example, would be capable of de-

termining the most efficient feeds, speeds, and depths of cuts for the job in question.

From the elements of Table I can now be synthesized the standard cycle of handling shown in Table III.

A saving of 43 per cent is thus effected in the cycle of handling, but the incidental operations shown in Table II remain to be considered.

Examining Table II with a view to the improvement of necessary operations, it appears that the workman finished all the stock from one box in Operation 10 and afterward dumped another boxful of stock onto the tray of the furnace in Operation 13. He then had his furnace entirely empty and had to reload it completely in Operation 14, and to wait in Operation 15 for the stock to heat. Supposing that the study of other boxes, omitted from Table II for brevity, shows this fault to be habitual, the necessary Operations 1 and 13 can be improved by causing them to be performed sometime before the preceding boxful of stock has been upset, so that there will always be a supply of stock on the tray of the furnace, and the revised cycle of Table II may not be interrupted by having to reload an empty furnace and wait for a heat after finishing each boxful of stock.

Since the revised cycle of Table III provides time for a continuous loading of the furnace, operations 3 and 4 and 14 and 15 of Table II become unnecessary and can be dropped.

As no other unnecessary or waste operations appear in Table II, a standard task and standard time may now be synthesized from Tables II and III, as shown in Table IV.

tensely on his work, or where he is exposed to physical hardship. All these allowances are merely empirical, and have not even a wide basis of experience. The matter is one in which scientific research is needed to give us the information required for accurate work.

In the illustrative case an allowance of 30 per cent for rest would be appropriate, because the workman is

TABLE IV

Operation	Time in Minutes
Upsetting 1,000 pieces of stock, according to cycle of Table III.....	48.
Necessary auxiliary operations (1, 6, 7, 9 and 13 of Table II) proportionate to number of pieces of stock (375 minutes $\times \frac{1000}{325}$).....	1.15

Total time for productive and auxiliary operations per thousand pieces of stock 49.15

The total time covered by the detailed part of Table II is 32.34 minutes. Therefore allowance may be made as follows for necessary and allowable interruptions shown by Table II.

Operation	Fraction of Total Time
Interruption, proportional to total time, operation No. 2 of Table II, (.03 $\frac{.03}{32.34} = .0009$).....	.0009
Visiting toilet, operation No. 11 of Table II, once in three hours $\frac{(3.180.)}{180.} = .017$	.017
Getting drink, operation 12 of Table II, once an hour $\frac{(1.0360.)}{60.} = .017$	.017
Total necessary and allowable interruptions.....	.0349

The total interruptions, as thus shown, are not enough for necessary rest. More information is needed on the amount of rest which workers require. Where a workman does little but watch a machine no allowance need be made. In ordinary cases it is common to allow about 10 per cent of the total time for rest. From this the allowance may increase with the severity of the conditions up to a maximum of 30 per cent of the total time. This allowance would be made where the workman is in continual physical activity, or where he is subject to nervous strain or anxiety, or where he is obliged to concentrate his mind in-

in continual physical activity and is exposed to considerable heat from the furnace.

The total stop-watch time per thousand pieces of stock equals.

$$\frac{49.15}{.7} = 70 \text{ minutes.}$$

As the error of the stop watch was 6.2 per cent, the correct standard time per thousand pieces of stock equals

$$\frac{70.}{.938} = 74.5 \text{ minutes,}$$

or approximately one hour and a quarter.

The time per thousand pieces of stock as roughly shown in the detailed part of Table II is

$$\frac{32.34}{.325} = 99.5 \text{ minutes,}$$

so that the operator was working at an efficiency somewhere near

$$\frac{74.5}{99.5} = 75 \text{ per cent.}$$

When the workman's performance has been brought up to the standard set, his production will therefore have been increased 33 per cent. It is to be noted that this is not to be done by driving the workman. On the contrary, he will have 30 per cent of his nominal working time for rest, while before he had none. The proposition is simultaneously to increase the production and to ease the workman by enabling the latter to eliminate wastes of time and energy and to work efficiently.

Errors in the result must now be detected by the application of checks.

Where piece rates are already in existence, the comparison of the worker's compensation under that rate with his compensation on the proposed standard furnishes one check. If, as usual, the piece rate has been established without the application of any other principle of efficiency, and if it was a fair rate under previous conditions, the worker's compensation under it will now be too high per unit of production, but too low per unit of time. In other words, by the time the establishment of standards for labor is undertaken, the general betterment should have advanced to such a point that a material increase in the rate of production has taken place, which should now, by the application of a bonus system of payment to standard tasks in standard times, be made to result to the advantage of both the employer and the workmen; of the former in cheapening labor cost per unit of production, and of the latter in increasing his compensation per unit of time.

After conditions have been standardized, a very accurate test of standard times established as the result of time study, is their comparison with one another. An example of this is given in Figure 1, which shows standard times for pointing stretcher rods. These are straight rods with threaded ends and no heads, and the operation was to turn the rounded point, like that on the threaded end of a bolt, on each end, in a special form of lathe.

The labor of handling being the only calculable work of the job, the natural assumption was that the work done and the time per thousand ends would vary directly as the weight of the rod; that is, directly as its length and as the square of its diameter.

The standard times to point one thousand ends were plotted, as in Figure 1, for a number of lengths of $\frac{3}{4}$ -inch rods and for one length of $\frac{5}{8}$ -inch rods. As to the $\frac{3}{4}$ -inch rods, the check was very satisfactory, the points plotting very close to a straight line up to 60 inches in length. There was another machine in such a position that handling rods of 60 inches and more in length was very awkward. The effect of this showed in the plotting of standard times determined for rods 60 inches and 66 inches in length, very nearly on another straight line parallel to the first, but above it, the intercept between the two lines measuring the effect on time of the difficulty of handling such long rods in the space available.

It will be noted that the line for $\frac{3}{4}$ -inch rods crosses the time axis some distance above the origin, indicating that there are certain elements of work that are constant regardless of the length of the rods. Such elements are the movements of the workman's own body, for ex-

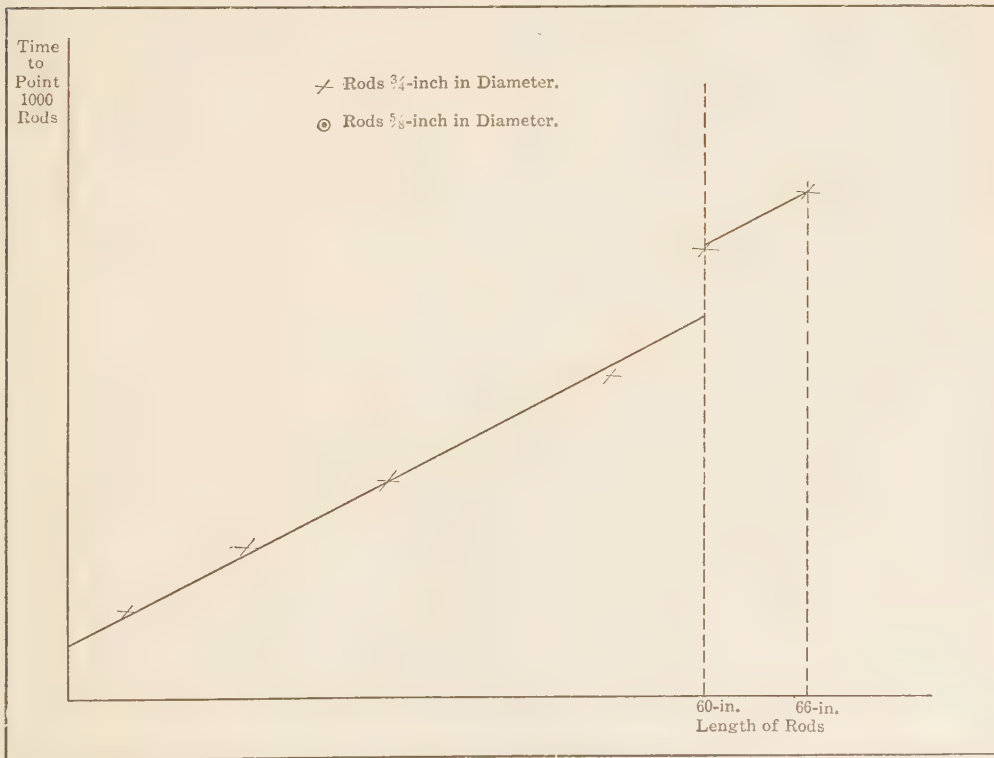
ample. The same thing is indicated by one point plotted for $\frac{5}{8}$ -inch rods, which lies higher than the ratio of squares of diameters would cause one to expect.

Emerson has called attention to the fact that, in athletics, the world's record is about twice as good as a reasonable continuous requirement from an ordinary man under standard conditions. For example, the world's record for walking is about eight miles an hour, while an ordinary man in good physical condition can walk about four miles an hour on a track. Emerson suggests that the same law may hold for labor.

Notwithstanding the almost complete absence from industry of the system of world's records which prevails in athletics, the above law is of practical application. A case has recently come to my knowledge in

which a manufacturer set a piece rate largely on an exhibition performance of a demonstrator in the employ of the maker of the machine on which the operation was performed. The result was that none of the manufacturer's machine operators could make more than 80 cents a day on the job, with the further result that any worker put on it immediately sought employment elsewhere, and the manufacturer had to find and break in a new man, who left in his turn as soon as he had discovered the limit to his earning power set by the severe piece rate.

A recognition of Emerson's law would have resulted in making the piece rate such that the operator could make about \$1.60 a day, which was almost exactly the average earnings of machine operators in this factory. Further, the general absence



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FIG. 1.

of industrial world's records suggests a line of research which should yield data of great value to the industrial engineer.

If the foreman under whom the work is done is intelligent and in sympathy with betterment work, a valuable check may be obtained by submitting the standard operation and time to his criticism and suggestions.

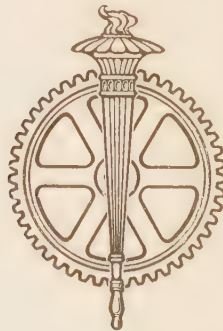
We had here reached a limit, that of the man's attainable continuous speed under the conditions. This explains why Table III did not make a further improvement on Table I by speeding up the machine, which, when running, was striking only $33 \frac{1}{3}$ blows per minute.

After all this, the standard must stand the test of actual use. Until it has had a week or two of such trial, it can be considered as only tentative and subject to revision. During this time, at least, it is very probable that the workers will require detailed personal instruction in order to accustom them to move exactly as called for by the standardized operation. Shop records should be carefully watched, after any standard time is

put in; and the men's performance must be improved by instruction and the elimination of the unfit.

If the standard is fair and instruction and elimination can be fully carried out, the average efficiency of the workers should gradually rise to about 100 per cent and remain there as long as conditions are the same, provided always that the group of workers fairly represents the average of ability. In any small group the last, of course, is apt not to be the case. Variation of the final average efficiency of the workers from 100 per cent should therefore be a cause for investigation, but not necessarily of a change in the standard. If after careful study the efficiency engineer remains convinced that the standard is a fair one for a worker of average ability under existing conditions, he should insist upon its acceptance by both employer and employees, no matter what average efficiency may be shown by the shop records.

It should not be forgotten that all this assumes standardization of conditions as a prerequisite for the setting of standard times.



CONSTRUCTION AND OPERATION OF TURBO-BLOWERS AND COMPRESSORS

By Franz zur Nedden

In the series begun in this issue, Mr. zur Nedden will discuss the mechanical evolution and operating economy of turbine machines for handling air or gases, in the same general manner as that which characterized his articles on the turbo-pump, published in this magazine January-May, 1910.—THE EDITORS.

THE introduction of the steam turbine as a competitor with the reciprocating engine was the certain forerunner of a similar change in the design and construction of pumps, and already the manufacturing of piston blowers and piston compressors is beginning to feel strong competition from the production of turbine machines built for compressing air or gases.

It was quite natural that the inventors and designers of the first practical steam turbine should be about the earliest workers also on the problems of its counterpart, the turbo-compressor; hence we find among the first builders of centrifugal blowers and compressors on a commercial basis the names of Hon. Charles A. Parsons and Prof. A. Rateau.

It may appear strange that turbo-blowers and compressors did not come into general favor as quickly as the high-lift turbine pump, although they made their appearance first at about the time when the first turbine pumps were built. This may be due to the fact that the superior economy of air or gas compressors or blowers of the turbine type becomes decidedly apparent only when comparatively large quantities are handled. The difficulties which the inventor of a new type of machine must face in his effort to induce works managers to take the risk of adopting an entirely new machine

are emphasized when the units in question are so large. With high-lift turbine pumps, on the other hand, decisive experience could well be obtained with small installations, and the enlargement of the turbine pump proceeded gradually from modest beginnings up to plants of more than 1,000 horse power.

The merits of turbo-blowers were nevertheless proved quickly enough for many purposes, and both blower and compressor (which latter, indeed, is only a number of turbo-blowers coupled in series) are rapidly growing in favor.

Perhaps a longer step toward the popularizing of turbo-blowers and turbo-compressors has been made as the result of the development of the exhaust-steam turbine. It is well known that the economy of the steam turbine increases directly with its rotative speed, and even electric generators at their highest speeds are slow-running machines when compared with the steam turbine operating at the number of revolutions theory points out to be the best. Here the centrifugal blower comes in, for, like the steam turbine, it also becomes more and more economical the faster it runs, and it is therefore the proper companion of the steam turbine. Speeds of 4,000 revolutions per minute and even more are quite familiar to the designer of turbo-compressors.

As large volumes of compressed

air are generally wanted only in plants where considerable quantities of exhaust steam are available at the same time, the coupling of an exhaust-steam turbine with a centrifugal compressor becomes obvious, and the combination is far superior in possible economy to the piston compressor driven by an electric motor or a high-pressure steam engine.

Generally speaking, the same advantages in practical operation which are so striking in the use of turbine pumps secure also the interest of the practical engineer in the applications of turbo-compressors. These adapt themselves to working demands with perfect ease, in most cases automatically, or with but a minimum of attention; and dispensing with all valves, they avoid the many troubles which valves entail. As the result of their simplicity, repairs are seldom needed, and wear and tear is very slight.

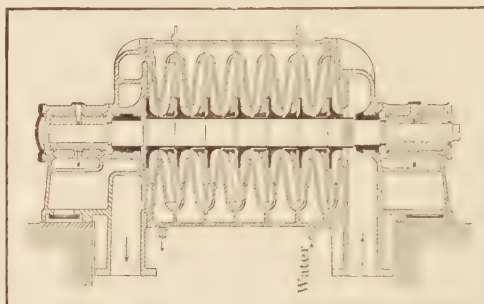
The small first cost and compactness of space requirement are other factors of economy; and an advantage which perhaps is most often welcome and which is not afforded by reciprocating machines, is that they need only light foundations.

DESIGN OF TURBO-COMPRESSORS

It is most interesting to observe that Rateau and Parsons dealt with the problems of design quite differently.

RATEAU BLOWER. Prof. Rateau did not take the structural features of his new machine from his steam

turbine, but from his high-lift turbine pump. The difference, indeed, between his turbo-compressors and turbo-pumps is so small that on a superficial inspection of the drawing the two machines might easily be confounded. (Figure 1.)

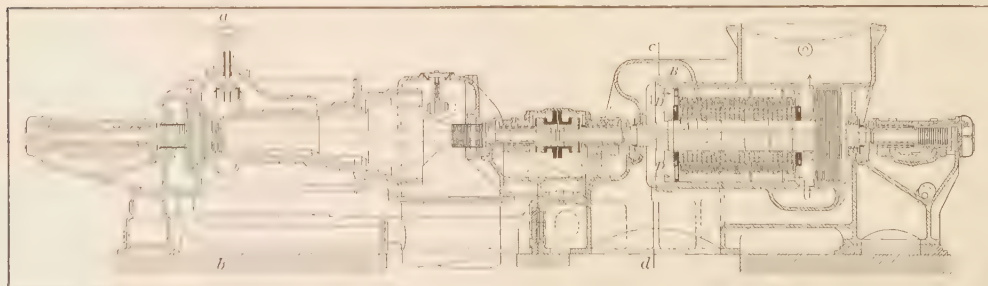


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FIG. 1. ORIGINAL RATEAU TURBINE BLOWER

The air upon entering the impeller near its nave, is seized by the impeller blades and thrown outward radially. Its speed upon leaving the periphery is changed into pressure in the fixed diffuser channel, and being laid back toward the center the air enters the second impeller to undergo the same process in a second stage and so on. Some essential differences in the design of details will be taken up later on.

THE PARSONS BLOWER. Mr. Parsons, on the other hand, made the turbo-blower merely an inversion of his steam turbine. Figure 2 shows a unit consisting of a standard Parsons steam turbine (on the left-hand side) coupled direct with a turbo-blower of the usual Parsons type, and delivering 1,600 cubic feet per



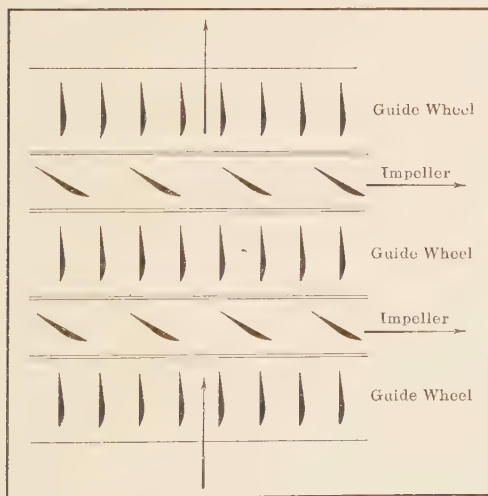
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FIG. 2. PARSONS TURBO-BLOWER DIRECT-DRIVEN BY PARSONS STEAM TURBINE

minute against a pressure of 6 to 20 inches of mercury at speeds varying from 2,400 to 3,400 revolutions.

The air is drawn into the chamber D, and laid into the periphery blades of the runner A by fixed guide blades B. The following blades are not shown in the section merely for simplicity of outline.

The principal divergence from the Rateau design is that the impellers of the Parsons turbo-blower throw the air in an axial direction to the next guide apparatus. Parsons undertook to transform the kinetic energy of the air as it leaves the impeller blades into pressure by simply opposing plain straight blades against its flow. The second guide wheel transmits the air axially to the second impeller, which again throws it axially into the third guide wheel, and so on. Figure 3 shows a developed section through several rows of blades.



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FIG. 3. DEVELOPED SECTION THROUGH IMPELLER AND GUIDE BLADES OF THE PARSONS TURBO-BLOWER

The excellent reputation of the Parsons machines helped the introduction of his turbo-blower, which was rapidly accepted and put into practical operation. At a time when Parsons' list of references showed more than a dozen blowers in opera-

tion or under construction, Rateau was still experimenting with his first turbo-blower. Nevertheless, Prof. Rateau succeeded in making up this backwardness and soon advanced to the point of combining several of his blowers in series, thus proceeding to obtain final pressures of 100 to 150 pounds per square inch. The excellent results which he and his assistant, Prof. Armengaud, obtained from their high-pressure machines induced even the licensees of Parsons steam turbine patents to secure rights for the Rateau turbo-compressors. A careful comparison of both systems will disclose some reasons for the rapid adoption of the Rateau system.

AIR LEAKAGE

The greatest difficulty in the way of obtaining high efficiency in turbo-compressors is the leakage of compressed air from the high-pressure stages into the stages of lower pressure. These leakages are due to the unavoidable clearances between fixed and rotating parts. Leakage losses are of course proportional volumetrically to the sectional area—that is, the diameter of the clearance, supposing equal radial dimensions, or furthermore, supposing equal standards of workmanship in the machine under comparison. The designer of a blower of radial type is able to reduce leakage to a minimum by placing the clearances between the stages as near as possible to the axis of the runner (see Figure 1). On the other hand, the axial system involves a maximum leakage, as it is impossible to avoid the location of the clearances at the points of greatest diameter (see Figure 2). Leakage involves a further thermic loss, and the air which escapes must not only be compressed a second time, but it has further a heating effect on the air contained in the lower stages. It is a fact proved by experiment

that gases flowing through narrow spaces at high velocity are considerably heated by friction. In the steam turbine this phenomenon contributes to the diminution of the loss caused by leakage, for the steam escaping through narrow clearances becomes superheated to such a point that it considerably improves the thermic condition of the lower stage.

This argument assists in understanding why the axial system is wholly acceptable in steam-turbine design, but injurious to the efficiency of turbo-blowers. In the design of a turbo-compressor it is essential to keep the diameter of the inter-stage clearances as small as possible.

Further considerations which perplex the situation of the designer of axial compressors may be discovered by considering the resistance of revolving discs. The discs of radial blowers transmit energy to the air practically over their whole area

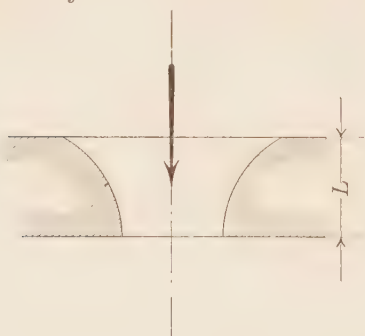


FIG. 4. NOZZLE FOR TRANSFORMING PRESSURE INTO VELOCITY

Note the difference of length, L , both

can not be kept as low with blowers of the Parsons type as with blowers of the various radial types. It must be admitted that the ratio of these losses amounts to a large percentage of the whole input of energy; about half the mechanical losses in the modern turbo-blower are due to frictional resistance of the impellers. This same phenomenon is less harmful in the steam turbine. Friction losses due to rotation are directly proportional to the density of the surrounding medium. In steam turbines only a few (and in exhaust



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FIG. 5. DIFFUSER FOR REVERSION OF THE PROCESS SHOWN IN FIG. 4

figures being drawn on the same scale.

from center to periphery; hence a greater amount of energy can be thus transmitted per stage than is possible with axial blowers, in which the gas is seized and compressed only at the periphery of the impellers. Even when in an axial compressor a whole set of sheaves is combined into a single group (a drum) the percentage of loss caused by the friction in the extended cylindrical surfaces

turbines not more than one or two) wheels revolve in steam at a pressure higher than atmospheric, all the following stages showing minor pressures, and the last one running in the best possible vacuum in which the friction losses are reduced nearly to zero. As turbo-compressors do not ordinarily work with suction pressures of any amount, the whole rotor must run in a comparatively

dense medium. Diminution of friction losses by reducing the number of stages and the revolving area subject to friction here become a much more urgent problem.

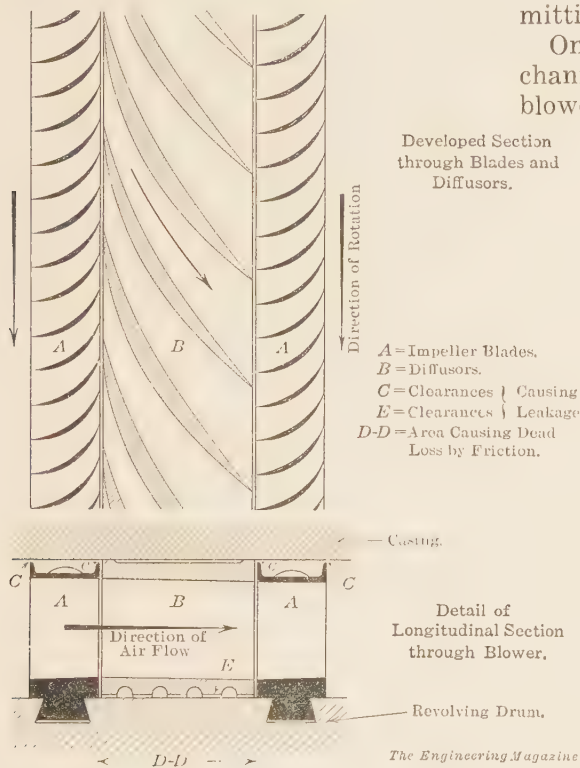


FIG. 6. CORRECT VANES FOR AXIAL TURBO-BLOWER

Finally, it is to be noted that the diffuser or nozzle used for transforming velocity into pressure must be much longer than that employed in the reverse process. This is illustrated by Figures 4 and 5. The space between two rows of revolving blades is quite sufficient to form a correct nozzle or guide wheel in the steam turbine, where pressure is transformed into velocity, but it is not sufficient at all for an equally effective diffuser. If in the design of an axial turbo-blower effort were made to introduce only fairly effective diffusers between the rows of impeller blades, impossible longitudinal dimensions of the drum would soon be reached. Furthermore, the

resultant long shafts would cause intolerable difficulties at the critical speed, and the long cylindrical areas (D-D, Figure 6) would cause enormous frictional losses when transmitting energy.

On the other hand, long diffuser channels are obligatory in radial blowers, as it is necessary to lead the air back from the periphery to the center after it has passed each impeller, and this of course, even though involuntarily, imposes an advantage, as a fairly perfect transformation of kinetic energy into static pressure is thereby obtained.

Mr. C. H. Jaeger, of Leipzig, who developed a turbo-blower of his own, was apparently well aware of the general advantages of the radial system over the axial system, for he also merely accommodated his turbine-pump design to the new conditions present when gases instead of liquids are to be pumped.

Figure 7 shows a section of a Jaeger turbo-blower. The resemblance to a multi-stage pump is again most striking. On more intimate study of this drawing, however, many differences appear.

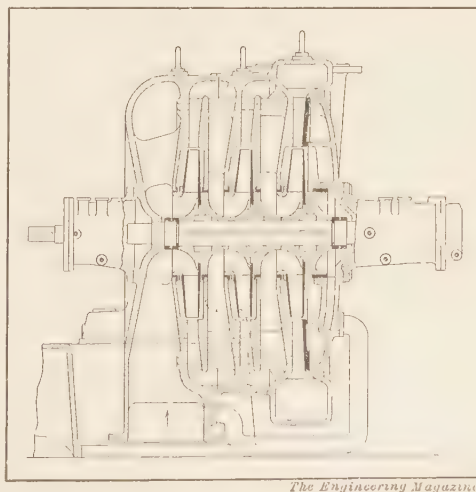


FIG. 7. JAEGER'S TURBO-BLOWER

The new conditions to be considered in the design of turbo-blowers (as compared with turbo-machines for pumping liquids) are based principally on the following physical qualities of gases: Compression of gas or air first reduces its volume, and secondly increases its temperature—both phenomena being unknown to the designer of turbo-pumps—while thirdly, the mass contained in the unit of volume is much smaller with air than with water. The relation between pressure in atmospheres (p) and velocity (v) may be generally expressed thus:

$$p = \frac{v^2 j}{2g}$$

g being acceleration of gravity, and j the specific weight.

Atmospheric air weighs only about one eight-hundred-and-thirtieth as much as water. It is there-

fore easy to understand that to generate the same pressures in both cases by mere centrifugal acceleration, the expression v^2 must be eight hundred and thirty times as great when compressing air as when lifting water against an equal pressure. In other words, an impeller which will lift water against a pressure of 14 pounds per square inch (equal to a head of 32 feet) with a circumferential speed of 40 feet per second, must be speeded up to a circumferential speed of 1,160 feet per second to produce the same pressure when dealing with air. As limitations in the strength of materials make it impracticable to revolve impellers at this enormous velocity, the designer of the turbo-blower, even though he use speeds up to 460 feet per second, must confine himself to smaller heads per stage.

THE BENGUELLA RAILWAY A SHORTENED ROUTE TO THE TRANSVAAL

By J. Hartley Knight

Engineering construction under unusual conditions is always interesting. The enterprise described by Mr. Knight has a special significance because of its relations to the great mining industry described by Dr. Hatch in our leading article in this issue.—THE EDITORS.

INCIDENTAL references to the Benguella Railway, which will run between Lobito Bay, in Portuguese West Africa, and Katanga, in the Belgian Congo, will be found in the articles on African railway progress which, during the past ten years I have been privileged to contribute to the pages of THE ENGINEERING MAGAZINE. Now that the line in question is beginning to loom large in the popular fancy—chiefly by reason of the fact of its being an important “feeder” to the trunk line known as the Cape-to-Cairo railway, which is gradually covering Africa from South to North—a somewhat

fuller account of its progress may not prove unwelcome, especially in view of the importance with which the line is regarded as a prospective “short cut” from Europe to the Rand goldfields in the Transvaal. Not so long ago prominence was given in the English press to a scheme propounded in the pages of the *Paris Matin* for constructing a line from Algiers, in Northern Africa, to Lake Chad and the Belgian-Congo region, where it would join the existing railways running through Rhodesia to the flank end of the sub-continent—a line that would “rival” the Cape-to-Cairo railway. The originator of the



MAP SHOWING WORK DONE ON THE BENGUELLA RAILWAY AND ITS RELATIONS TO THE RAILWAY SYSTEMS OF EAST AFRICA

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new scheme is M. Berthelot, and the point of his proposal is that his line would enable the traveller to cut short the present sea trip to South Africa, and reach Johannesburg in nine days from the date of his leaving London, which is, of course, just half the time it now takes to perform the journey by sea and rail. The idea of such a railway is, however, not quite so new as the *Matin* would have us believe. Readers of THE ENGINEERING MAGAZINE may remember that a very similar notion was put forward in these pages some years ago—in October, 1905, to be exact—by Sir Charles Metcalfe, the eminent engineer, who has done such splendid work in the construction of the Rhodesian section of the Cape-to-Cairo line. He says:—

My own opinion is that in the future there will probably be two

lines running from Broken Hill—one going up through the Congo Free State, to Lake Chad and right through French territory, coming out perhaps at Algiers or some other place on the North Coast; the other running up through German East Africa and ultimately joining up with Khartoum and Cairo.

When this opinion was advanced there was, of course, no question about shortening the journey to Johannesburg—certainly not, at least, by a line which began (or ended) at Algiers; though there is not much doubt that Sir Charles Metcalfe and his coadjutors foresaw that the time would arrive when the line that had then just been commenced at Lobito Bay, in the Portuguese Colony of Angola, in West Africa, would not only link up with Rhodesia Broken Hill but would ultimately also connect with Johannesburg.



A SURVEYING PARTY

Nowadays it is obvious that if there is to be in the near future any shortening of the journey from England to the Rand, it will inevitably be by way of Lobito Bay on the west coast—the line known as the Benguella Railway—rather than by Algiers on the north. This would effect a saving of two or three days at least. Already the project has caused some commotion in Cape Town, which sees much of the import trade with the Transvaal, of which she handles so large a share, being diverted to Lobito Bay and carried thence to Johannesburg by means of the Benguella Railway. Personally, I do not think there is much ground for uneasiness on this score; though there is hardly any doubt that when the Benguella line is completed, Rhodesia will take advantage of the fact and import much of her mining and railway material by this means. And it is also within the bounds of probability that to some extent also the Transvaal will follow Rhodesia's example,

though for many years to come it is safe to assume that the bulk of the Transvaal's requirements in the way of goods will be imported via Cape Town, Durban, and Delagoa Bay. But the Benguella railway cannot fail to prove of enormous help in the development of middle Africa, and perhaps that is one reason why Germany is so anxious, as is generally believed, to acquire the Portuguese colony of Angola.

The late Mr. Cecil Rhodes once said that the object of the Cape-to-Cairo railway was not to enable a traveller to "get in at Cairo and get out at Cape Town." Travelling of the kind would be inconceivably tedious, and the same objection would certainly apply to a journey between Algiers and Johannesburg. Undoubtedly, then, the "short cut" to the Rand will be made by means of the Benguella Railway. That line, which will run almost due east to Katanga for upwards of a thousand miles, has already made good prog-

ress, some 225 miles of it having been formally opened in July last by Mr. Robert Williams, the moving spirit in the scheme, and the next stage eastwards being now under construction. At the Belgian Congo end, the line (coming up from Rhodesia) has already reached Elizabethville, and the next section—westwards to Kambove—is now in hand. Thus the line is being constructed at both ends. The intervening stretch of territory presents little or nothing in the way of engineering difficulties, being, in the words of Mr. J. Norton Griffiths, M. P., whose firm constructed the rack section from Benguella—"as flat as a billiard table." Probably the next three years will see the completion of the line, the ostensible purpose of which, however, is not to lessen the distance to the Rand goldfields but to assist in the exploitation of the Katanga min-

eral district, as to the richness of which astonishing statements are in circulation.

As in former articles I have referred in some detail to the construction of the rack incline at the Benguella end, there is no necessity to go over that particular section again. Suffice it that the water supply for the engines during construction was a matter of great difficulty, and all construction trains had one or more 20,000-litre capacity tank wagons attached to them, which had to be hauled up the 1 in 16½ gradient of the rack incline. The difficulty has since been met by installing powerful steam pumps at various points *en route*, and beyond Caimbambo to the Belgian Congo frontier ample water supply is now available. Such works as were left incomplected to Kubal by Messrs. Griffiths & Co. were afterwards finished departmentally by



ALONG THE LINE OF THE LOBITO BAY RAILWAY



CROSSING LUALABA RIVER, 11 MILES FROM RUWE,
BELGIAN CONGO

Mr. Edward Robins and Mr. H. F. Varian, respectively chief resident engineer and chief assistant to Sir Douglas Fox and Partners, the consulting engineers.

At kilometre $50\frac{3}{4}$ the line enters the Rigenback rack section, on a gradient of 1 in $16\frac{1}{2}$, with curves of 150-metres radius, up which the train is pushed for a couple of kilometres by a specially designed and powerful locomotive and tender of German construction. After leaving the rack the line crosses the San Pedro river on a steel viaduct of four spans of 18 metres each. Thence the line begins to climb and to descend and to rise again until, at the top of the divide between the Epuka and Kubal rivers, an altitude of 933 metres is reached. The altitude of the railway at kilometre $356\frac{1}{2}$, however, is 1,481

metres (4,858 feet). Heavy works in cuts and fills were begun some few months since on a new contract with Messrs. Pauling & Co., to kilometre $426\frac{1}{2}$, where it is intended to place an important station to accommodate the Huambo district. This point reached, the line will run at the top of the Great Divide, as it is called, when the works to the Belgian Congo border become of an easy character. The line is of 3 feet 6 inches gauge



BLASTING OPERATIONS IN THE CONSTRUCTION OF
THE BENGUELLA RAILWAY



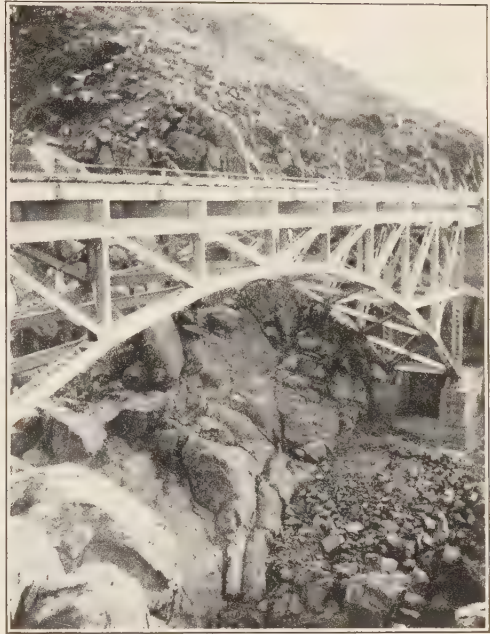
ON THE BENGUELLA RAILWAY

throughout and is laid with flat-bottomed rails weighing 60 pounds to the yard, on steel sleepers, weighing with the keys 70 pounds each, spaced 13 to the 10-metre rail, which is one more sleeper to the rail than is used on the Rhodesian railways. The fuel used throughout is of Cardiff briquettes, local timber having been found unsuitable for engine purposes.

Mr. Douglas Fox, M. Inst. C. E.,

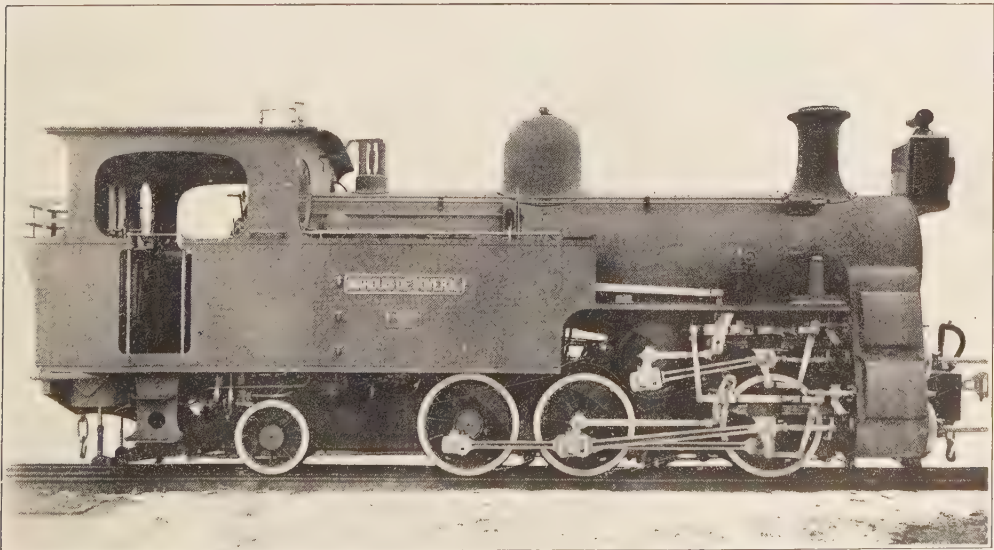
who recently made the through journey from Lobito Bay to Katanga, told me the other day that during the earlier portion of construction Senegalese and other natives of West Africa, as well as Indian coolies from Natal, in Southern Africa, were imported for the work, but that these have since been repatriated. The best natives now employed on the line are the Quilengue, from the south-east Benguella district. They are splendid workers, Mr. Fox says, and compare favourably with the native labourers of the east coast. The native labourer performs 19 days' (10 hours a day) work per month out of the 26 working days, his wages averaging 106 reis per day, the company supplying Indian meal or a rice ration free, according to the food the men are accustomed to in their own country.

At Lobito is a natural harbour equal to any and superior to most in Africa. On the inside of the remarkable sand spit there the sand shelves very rapidly at a slope of about 2 to 1 and enables steamers of the largest size to move close alongside. I understand that Major Roma Machado, the



VIADUCT ACROSS LENGUE GORGE

Portuguese Government fiscal engineer, has elaborated a complete scheme for the development of the sand spit, and there is not much doubt but that in the near future Lobito will become the most important town in that part of Africa. Already a great deal has been done



RACK ENGINE, BENGUELLA RAILWAY



FERRYING THE BED OF A WAGON AT EKOLA CROSSING



CUMA STATION, BENGUELLA RAILWAY



RHODESIA BROKEN HILL MINE, SHOWING TRAMWAY FOR CARRYING ORE TO CALCINING FURNACES

not only in the development of Lobito itself, but also of Benguella and Catumbella, and all three towns, I am informed, will shortly be in possession of cheap electric power and light. Vast quantities of material of all sorts are daily being imported into the country, and as the line advances existing towns will be developed and others will spring up, and so a vast region now given over to barbarism will be opened up to commerce and agriculture. At the Belgian Congo end of the railway line copper-smelting has been already successfully started, and Mr. Robert Williams lately officially reported

that he had seen sufficient ore developed in the locality to produce 600,000 tons of copper. The railway section from Elizabethville to Kambove—which is also being constructed by Messrs. Pauling, who thus have the distinction of building the Benguella line at either end—is expected to be completed within a year.

The various groups of mines in the fulness of time will be connected by railway—which will, of course, mean further big demands for large quantities of constructive and other material. To an engineering audience the significance of these demands is unmistakable.

COST METHODS THAT GIVE THE EXECUTIVE CONTROL OF HIS BUSINESS

VI. STATISTICS AS AN AID

By Benj. A. Franklin

Mr. Franklin's purpose, as explained in introducing the first paper of the current series, is to exhibit the use and compilation of costs from the standpoint of the executive rather than that of the cost clerk. Beginning with the principles and elements that must be recognized to make a cost statement a true and instant revelation of actual conditions, he proceeds to the character of the reports that must come periodically to the manager's desk, and then to the methods by which such data can be obtained and assembled. Actual details or devices of cost collecting are discussed only so far as they are important and interesting to the executive. His topics so far have been: "The Philosophy of Costs"; "The Place of the Trial Balance in the Cost System"; "The Cost of the Salable Article"; "The Economic Consideration of Material by Costs"; "Labor from the Cost Viewpoint", and "The Vexing Question of Expense". The concluding article of the series will appear next month.—THE EDITORS.

IN the study of the progress of the manufacturing situation through figures, it is not sufficient that the executive give consideration only to the bare costs of articles, or to the showings of material, labor, and expense conditions alone; for these figures, valuable as they are, are merely reflections of conditions into which enter yet other elements very vital to ultimate welfare. Without a proper knowledge of these elements and their variations, the progress and possibilities of the situation are not well brought out, and policies of operation looking towards the future (for the wise executive thinks always for the future, realizing how swiftly it merges into the present) are not well founded on the facts, or frequently are not even suggested.

A cost system must then be buttressed with statistics. These statistics should be preferably a part of the cost-department's work, since they interlace with and support the cost system, and, in fact, have to do with facts frequently already a part of the cost situation, but in connections and guises different from those which, in the form of separate statistics (for costs are merely statistics

remodeled) are necessary to show their value and relation to the moving situation. Many plants, of course, have certain statistics, even when they have not costs, but such statistics can not render the most complete values.

There need be no lengthy arguments advanced as to the value of statistics. They are simply essential as a presentation of running facts illuminating conditions for the enlightenment of the executive, so that his judgment and energy may be guided by certain knowledge. Too often, without them, impressions based on isolated occurrences which are not representative tend to lead the executive astray. With them the course may not always be clear, but it is much easier to steer.

Nor are there any theories of presentation, except those dictated by common-sense, as to showing the facts so that they will make the situation quickly clear. Of course the principles of the cost philosophy apply here. Accuracy, standards, comparisons, arrangement, periodicity, as previously explained, are plainly essentials to statistics of value. Imagination, practical instinct and co-operation of the execu-

tive organization will be found to be vital necessities in the attainment of results of maximum value through statistics. The discussion on statistics becomes, then, almost a simple recital of facts to be illustrated.

The first important series of progressive facts marshalled under the head of statistics should have to do with the selling situation. From the statistical point of view there are three conditions to be considered in their relations to each other—the volume of sales of salable articles, the market, and the means of connecting them.

It is not the scope of this article to deal with particular methods of selling or of getting results in this vitally important department of manufacturing plants, except to point out that from statistics and their study naturally will flow suggestions of desirable or necessary policies, through indications of tendencies shown toward either good or poor results; and that, likewise, on the opposite hand, statistics will show what are the results of certain practical plans and methods.

The statistics of articles from the selling point of view have to do, in very many plants, not merely with the details of shipments, but frequently more importantly with the

details of orders as they arrive. In many cases shipments are seasonable but orders must be taken well in advance, and the volume and significance must be known continuously so that proper and economical manufacturing arrangements may be made. In other cases these facts must gauge the question of volume of stock to be made up and carried. But, more significantly from the strictly selling point of view, it is important to know the ratio of low-profit and high-profit goods sold (for every factory has the two classes) the ratios of different grades, sizes, etc., of the same article as sold, and, especially and particularly, the progress of sales of the different lines over definite, active periods as compared with similar previous periods, for these facts gauge the market conditions and the value of means of connecting with the market, which knowledge is very essential.

Generally speaking, then, there should be detailed statistics showing volume of orders on hand of different articles, which can readily be kept up daily or weekly by adding orders and subtracting shipments; which record will permit economic anticipation and arrangement of the manufacturing situation. Likewise there should be detailed period rec-

ORDERS—PRODUCTION SHEET

FORM 21

Article	Week of 5/4/12			Week of 5/11/12			Week of 5/18/12	
	On Hand	Orders	Pro- duction	On Hand	Orders	Pro- duction	On Hand	
A	2,082 gross	10,118	8,260	224	12,096	11,250	[622]	Etc.
B	[1,876 “]	2,800	1,500	3,176	3,200	2,508	[3,868]	Etc.
C	24,126 doz.	12,260	15,960	27,826	9,218	16,260	34,868	Etc.
D	526 “	300	350	576	80	0	496	Etc.
E	100 “	5	0	95	10	0	85	
F	82,327 “	57,118	72,116	97,325	65,000	62,918	95,243	Etc.
Etc.		Etc.			Etc.			

[] indicates amount of orders ahead of stock on hand.

ords of sales of different articles, comparable always with the records of previous similar periods, in order to show their progress backward or forward. Forms 21 and 22 illustrate such methods. It must be understood, however, that in each business its own peculiarities must be met and the forms illustrated can only furnish general ideas. From such a form as Form 21 it is plain that a constant knowledge of the necessities of production is to be had, and this form, of course, can

conditions of sections, show readily the proper points of attack and contact and bring about the increasing of lines, both in variety and quality, with customers already made. Forms 23 and 24 illustrate possible methods. Form 23 gives merely the viewpoint of locality of sales, and may be put into as much detail of territory and articles as desired. Form 24 shows possibility of analyzing customers' sales and comparing them with previous periods. It will be understood, of course, that none of these forms

SALES RECORD

FORM 22

Approx. % Profit	Article	Month April	Period to date	Month May	Period to date	Etc.
9%	A.....	\$2,082.95	\$9,626.12	\$3,187.13	\$12,813.25	
20%	B.....	586.12	1,816.17	617.90	2,433.07	
15%	C.....	3,600.12	15,612.21	3,212.82	18,824.93	
25%	D.....	487.10	1,230.09	320.05	1,550.14	
40%	E.....	93.12	510.19	87.12	597.31	
12%	F.....	15,216.10	59,387.16	16,916.20	76,303.36	
	Etc.		Period Fig- ures in Red		Period Fig- ures in Red	

be varied to give this knowledge over any period, or for present and future orders. Given the knowledge of productive ability in the plant, this form, especially adaptable in the shown conditions to staple articles, becomes a definite forecast.

Form 22, if the figures are compared with the figures of similiar previous periods, and if some mark is attached to show percentages of profit on the different articles, becomes very essential in the struggle to keep the most profitable articles to the front.

In the matter of markets, proper statistics will show where the sales are made according to territories, and, in a varied line, even according to customers. These facts, together with some study of population and

are offered for copy, but merely to suggest possibilities in different directions, in the simplest way.

The third point of value, then, in sales statistics arises in a study of the means of connection between the article and the market. This, in very many cases, will mean a study of the results from salesmen. An executive, naturally, for judgment as to value, desires to know the relation of the sales by a salesman to his salary and expenses, but with a proper cost system he should and can preferably know the relation of the profits on the sale to the cost of obtaining them, because, frequently, the salesman with the low percentage of cost to the sales may have a high percentage of cost to the profit on the sales, due to selling prin-

SALES BY SECTIONS

FORM 23

Section	Jan.	Feb.	March	April	Etc.
New England.....	\$1,218.90	\$1,326.20	\$1,561.27	\$1,819.16	
New York.....	13,216.51	13,528.19	13,018.17	12,812.19	
Chicago	4,221.63	5,320.17	3,690.12	3,218.70	
South	450.19	620.82	732.16	691.17	Etc.
Etc.		Etc.			
Totals					

cially low-profit goods, or of constant concessions in price. The plant with a good selling force has made a long step toward prosperity, and a good sales force is only exceptionally built without a basis of the facts. Form 25 illustrates a method of observing salesmen's results.

The value of advertising, while it may not be always definitely measured, should be shown by statistics giving the relation of advertising cost to the sale of the articles advertised and its effect in districts, where possible.

Such statistics of selling, to which may be added others suggested by circumstances or the peculiarities of business, will keep the whole situation plain as to its tendency, will keep the force keyed up to constantly bettering the results, and will lead to policies and plans for improved results.

The next important use for statistics has to do with production. It is hardly needful to repeat that because of possibilities of cost reduction in labor and expense, the struggle in every factory is to get the maximum

CUSTOMERS' SALES—JOHN JONES & Co., CHICAGO

Form 24

	A	B	C	D	Etc.	Totals
Jan.	\$326	\$28	\$412	\$6		\$1,112
Feb.	518	128	618	10		1,326
Mar.	107	56	729	40		1,016
Apr.	812	210	926	0	Etc.	1,420
May	125	15	1,125	0		602
June	Etc.	Etc.	Etc.	Etc.		Etc.
July	Etc.					Etc.
Aug.						
Sept.						
Oct.						
Nov.						
Dec.						
Totals	\$5,621	\$1,108	\$6,401	\$180	Etc.	\$14,201

Dollars only used. Cents not noted.

WEEKLY COST AND HISTORY

Item	Week 5/18/12	Period to date	Week 5/25	Period to date	Week 6/1	Period to date
<i>Labor</i>						
Direct—Piece Work.....	\$125.60	\$2,335.39	\$129.92	\$2,565.31	\$122.58	\$2,589.74
" Day Work.....	27.50	494.00	32.50	526.50	23.50	550.00
Av. Cost per Hundred.....	.244	.242	.25	.242	.238	.242
<i>Expense</i>						
Indirect Labor.....	317.93	6,019.41	198.82	6,218.23	258.22	6,476.45
Supplies	20.50	220.00	21.50	241.50	20.50	262.00
Power	10.12	57.96	3.08	61.04	2.16	63.20
Power	107.16	2,086.78	109.12	2,195.90	118.22	2,314.12
Repair	42.96	397.78	0	397.78	15.18	412.96
Depreciation, etc.....	55.00	1,100.00	55.00	1,155.00	55.00	1,210.00
Miscellaneous	82.19	2,156.89	10.12	2,167.01	47.16	2,214.17
Direct Hours.....	5,103	123,604	5,414	129,018	4,832	134,850
Expense Cost per hour.....	62 cts.	48.7	36.7	48.2	53.4	48.1
<i>Production</i>						
Av. Total Cost per Hundred.....	62.800	1,167,696	64,960	1,232,656	61,218	1,294,874
Labor and Expense.....	.75	.757	.55	.746	.66	.74
<i>Waste</i>						
Amt. Seconds.....	5,024	58,380	3,897	62,277	2,448	64,725
Amt. Waste.....	642	7,000	454	7,454	672	8,126
% Seconds.....	8%	5%	6%	5%	4%	5%
% Waste.....	1%	.6%	.7%	.6%	1.1%	.6%

Period figures to be entered in red, to distinguish them from figures of the week.

SALESMEN'S SHOWING—B. SMITH

FORM 25

Article		Month Sales	April Profit	Month Sales	May Profit	
A	Month....	1,012.12	91.80	2,062.19	185.59	
	Period....	4,629.20	416.61	6,691.39	602.20	
B	Month....	300.16	60.03	417.26	83.45	
	Period....	1,213.87	242.75	1,631.13	326.20	
C	Month....	2,500.10	375.01	2,200.16	330.02	
	Period....	9,000.26	1,350.06	11,200.42	1,680.08	Etc.
D	Month....	187.90	46.98	120.19	30.05	
	Period....	512.69	128.16	632.88	158.21	
E	Month....	5.12	2.04	6.20	2.48	
	Period....	102.18	40.84	108.38	43.32	Etc.
F	Month....	8,612.91	1,033.54	9,200.12	1,104.00	
	Period....	32,650.52	3,918.00	41,850.64	5,022.00	
Etc.		Etc.	Etc.	Etc.	Etc.	
Totals, Month		12,618.31	1,609.40	14,006.12	1,735.59	
" Period		48,108.72	6,096.42	62,114.84	7,832.01	
Sal. and Exp., Month.			502.28		532.19	
" Period.			2,082.16		2,624.35	
Per cent to Profits..		Month	31%		30.7%	
" " "		Period	34%		33.5%	
Period Figures in Red.						

production in given units of time—from men, machines, departments, and the factory. This struggle, to be maintained, requires the constant trail of comparative statistics.

There is, of course, an art, a trick of swift and clear illustration in statistical showing. It is neither possible nor desirable to keep great detail of production at every point, but total of articles in given periods (sometimes in units of weight or quantity, and sometimes in value) can be kept constantly with the idea of analysis downward, when desired. And most particularly is it valuable if the "squeeze point" or point of most difficult production be found, and the record of progress there be kept. With such statistics of production it is frequently necessary to show, also, certain facts of essential connection, as speeds of machines, temperatures, weather conditions, etc. to explain them and their variations.

Of course a very vital point, not to be passed by, is the relation of production to the running sales, in connection with the stock on hand, in order that proper plans for the future may be considered, and in order that neither may the sales run far ahead of the production, causing complaints of delay and cancellation, or the production much exceed sales, causing an expensive and dangerous piling up of stock. Statistics of manufactured goods unsold, on hand, almost always amply pay for their cost of up-keep. I have in mind several important concerns, which, on account of the former difficulty (due wholly, not to a lack of *statistics*, but of *illuminating* statistics) lost much trade; and at least two concerns, which, because of the latter difficulty found themselves compelled to assign. In the case of these concerns the proper statistics would have been worth thousands of dollars.

Form 21, already referred to, illustrates a simple method for plants of some kinds.

The statistics of sales and production, and, of course, of consequent completion of sales by shipment, together with the cost method indicated in previous articles, including the statistics of waste, labor operations, and expenses there shown, cover fairly completely the main situations, in the light of fact illustration. There are, however, as every inquisitive and investigating executive will discover, innumerable other desirable points of knowledge, which seem to demand illumination through statistics. Almost every detail of manufacture seems to be susceptible of further enlightenment. But the wise executive, before covering too minutely the manufacturing situation with statistics, will consider the possible values to be obtained, the time of what people can be properly put into consideration of such facts, and the cost of obtaining them. Where a probable real value is to be obtained, it would not be wise, of course, to pass over too quickly any investigations. But it must be remembered that, however beautiful the theory and thought that every situation is made clear by compilations of facts, nevertheless, it is often fully as great an economic folly to be overburdened with facts to be studied and assimilated, as it is to depend on judgment and watchfulness alone unilluminated by a systematic trail of fact-pictures.

It is often valuable to plot the statistics into curves, particularly as showing tendencies or relations of several factors over continued periods. In general, however, such curves can show only tendencies, and they are mainly valuable to the executive who may desire to use them to make plain the situation to others above or below him. Gener-

ally he, himself, will follow the figures.

A wise method to pursue always in designing statistics is to start with general compilations covering the larger situation, and only go further into details down as the situation seems to demand. Thus the executive can generally study each situation from the large point of view, and his judgment in digging deeper will be guided purely by the apparent necessities of each situation rather than by the mere desire to compile statistics.

There is illustrated in Form 26 a combination set of statistics and costs called the "Weekly Cost and History." As will be seen, this form illustrates the whole progress of a department in labor, expense, production, and waste for week after week comparatively. It is not advised for all plants, nor as the best method to be operated continuously for any one plant, but as a method of getting a department into good shape and under control it has been found a simple and valuable method. The facts shown, of course, may be varied to suit the situation and the desires of the executive.

No executive can afford to spend the larger part of his time studying statistics, but it is only the common-sense of his duty to review the different sections of his factory situation periodically, with the idea of assuring himself of their progress according to plan, or of planning future steps of progress; and that executive who believes in his own ability or that of his subordinates to do these things purely on their impressions or judgment, is taking a long chance on his plant's success. Since so much of success depends on human effort, it is never amiss, but always well, to judge of future possibilities by past records, and statistics lend this opportunity.

FLOORS AND FLOOR CONSTRUCTION FOR MANUFACTURING PLANTS

By Henry Grattan Tyrrell

Mr. Tyrrell's discussion will be presented in two parts following the division indicated in his opening words. The section on upper floors will appear in our August issue.—THE EDITORS.

FACTORY floors may be divided into two general classes, (1) ground floors, (2) upper floors, and in each case a distinction must be made between the structural parts and the wearing surface or finish. The various kinds of floors will first be described in order, after which will be given the types which are best suited for different shops and industries, the choice depending in each case upon the character of work done and the size and weight of products and machinery. Wood, asphalt, clay, brick, concrete, and metal, are all suitable in their places, and they will be described in detail in later pages. In some buildings, such as forge shops, a dirt or cinder floor is the best, while only a hard and dustless surface is suitable in rooms where fine instruments are made.

GROUND FLOORS

Ground floors should be built like good street pavements, being extra solid for heavy work and loads, and less permanent for lighter service. The common forms are—(1) Earth, (2) Wood Block, (3) Plank Floors, (4) Tar-Concrete and Wood, (5) Cement Concrete and Granolithic, (6) Asphalt, and (7) Brick.

Shop floors should generally have a slight grade, preferably in the direction of the greatest travel, not only to facilitate drainage, but also to make easier the starting and movement of loaded trucks and cars. Where water is freely used, as in car

sheds and round-houses, good drainage is imperative, for the best work cannot be done when men are standing in water with their feet wet. In the construction of steel-frame buildings, the contract for which is frequently placed with a structural-steel company in a distant city, the ground floor can usually be more cheaply made by a local builder who is familiar with the local conditions and the source of supplies.

EARTH FLOORS. These are perhaps the simplest kind of shop floors. There should first be laid a bed of sand over which cinders are spread, and this should be well compressed and flooded with the hose every day for two or three weeks, being rolled each day after wetting. Instead of cinders, a mixture composed of one part of clay with three of gravel may be used, spread 8 to 12 inches deep and rammed, the clay acting as a cement or binder for the gravel. In any case, the floor must have a top layer of fine cinders or sand to prevent mud from forming on the surface.

WOOD-BLOCK FLOORS. Wood blocks make an excellent shop floor, one that is easy to walk upon, with little or no liability to slipping. When not subject to moisture or water soaking, the blocks can be used in their natural condition, and they must then be laid with 1/4-inch open joints for expansion, the joints being filled in with sand. When exposed to weather the

blocks should be creosoted and the joints filled with sand and pitch or cement grout; the floor should then endure for a period of ten to twenty years.

A good specification for a wood-block floor is to spread first and thoroughly compact a layer of gravel or cinders 12 inches deep over which is laid 4 inches of concrete. One or two inches of sand is then spread and rolled, and on this are placed the wood blocks. A modification of this floor, Figure 1, was used in a large shop, 330 feet wide and 776 feet long, for the American Bridge Company at Ambridge, Pa. The slag base was first spread and rolled, and on this was placed a 6-inch layer of tarred gravel covered with 1 inch of tarred sand. On this were set the maple and beech paving blocks, which were 4 by 4 inches, 8 inches long, the grain of the wood being vertical.

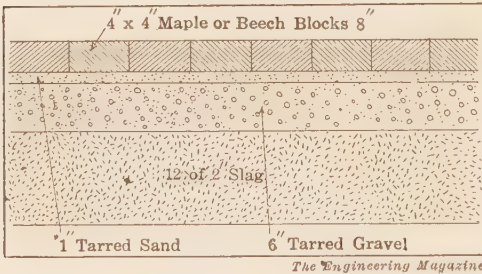


FIG. 1. WOOD BLOCK ON CONCRETE

Instead of the concrete base above described, a 2-inch layer of sand is sometimes spread over the bottom course of gravel or cinders, and 2-inch plank laid thereon, as a base for the wood blocks. This latter method has the disadvantage that the plank distributes vibrations, and as the plank decays, a larger area must be removed for renewing or replacing it. This type of floor, Figure 2, with oak blocks 5 inches high and 6 to 12 inches long, was used in the car shops for the Illinois Central Railway Company at Chicago. The 2 by 12-inch hemlock planks forming the base

were laid on sleepers embedded in sand.

Wood blocks may be used also for upper floors by placing under them two layers of paper laid in pitch, and jointing the blocks with paving pitch and sand. This floor is suitable also in foundries excepting within a few feet of the ovens.

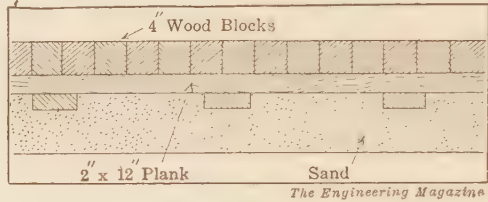


FIG. 2. WOOD BLOCK ON PLANK

PLANK FLOORS. Wood Floors are the most comfortable to walk and work upon, and are usually the best excepting in places where they would be destroyed by chemicals, moisture, or heat. The comfort of employees in working on wood floors is important and worth considering, for men can do their best work only when contented and comfortable. The preference of workmen in this respect is shown by the replies received from forty different factories, from twenty-six of which a decided choice was expressed for wood over any other kind of wearing surface.

Pine flooring is perhaps the best when the life has not all been tapped out of the tree before sawing it into boards. Flooring boards for upper surface should not exceed 3 to 4 inches in width, and they should have hollow backs and be laid in the direction of the greatest travel. Flooring $\frac{7}{8}$ -inch thick is quite as good as $1\frac{1}{8}$ -inch, for when the thinner boards are worn away enough for renewal, it would also be time to replace the thicker ones. Maple wearing surface in short lengths is satisfactory, for it can be easily repaired. Two layers of tar paper should be placed between the upper and lower courses.

The lower course should preferably span two bays or panels for the sake of greater strength or stiffness. Planks 3 inches thick or more should have splines rather than tongue and groove, though when floors are used for trucking, the upper boards should have square edges, as grooved edges break under heavy loads and wheels. Blind or edge nailing interferes with repairs and is therefore not desirable. Four-inch planks should have 7-inch steel spikes, one keg of 100 pounds being enough to lay 1,200 square feet of floor.



FIG. 3. PLANK FLOOR TEMPORARY TYPE

All wood floors have the disadvantage that water used in cleaning them will soak into the cracks and cause the boards to expand and form ridges. It is important, therefore, to devise methods for preserving them, one good process being that of creosoting. In this process, the wood is first dried and the creosote oil is then forced into the wood under a pressure of 150 pounds per square inch. Unseasoned timber must remain unpainted, for paint on such material is worse than none at all. After two or three years, when the wood is dry, it should receive three coats of oil paint. The timber must also be well ventilated to prevent destruction from dry rot.

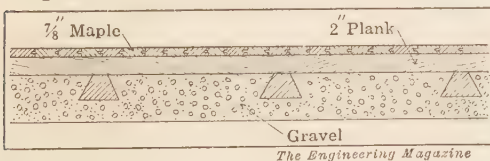


FIG. 4. LOW-COST PLANK FLOOR

Figure 3 is a very cheap and temporary floor made by placing 3-inch plank on half-round timbers, 3 feet apart, embedded in 6 to 8 inches of cinders, the wood being coated on the under side with lime. Its cost is very

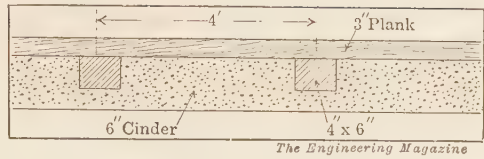


FIG. 5. TEMPORARY PLANK FLOOR

low, being only 50 cents per square yard. A floor similar to this with 2-inch plank on chestnut slabs, embedded in gravel over made ground, decayed within a year, and thereafter about half of it was replaced each following year. In the immediate vicinity was another floor with 2-inch plank on 3 by 12-inch joists, supported on 12 by 12-inch sills, and masonry piers, which required no renewal for a period of twelve years. A floor similar to Figure 3 with sills embedded in sand instead of cinders, was used twenty-five years ago in a shop for William Sellers & Com-

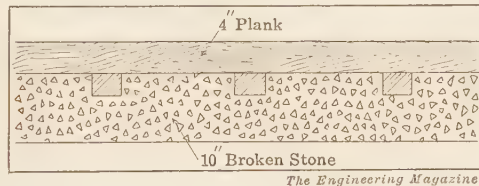


FIG. 6. MEDIUM PLANK FLOOR

pany of Philadelphia, an effort being made to preserve the plank by placing under it a $\frac{1}{4}$ -inch layer of resin.

Other plans for temporary wooden floors are shown in Figures 4 to 6. They have the advantage of low cost, Figure 5 costing not over 10 to 12 cents per square foot, with lumber at \$30 per thousand feet, board measure. If a concrete base were used instead of cinders, the cost would be 25 to 30 cents per square foot.

Figure 7 is a floor heavy enough to carry ordinary machines anywhere without special foundations. The 8-



FIG. 7. HEAVY PLANK FLOOR

inch concrete base is first laid and rammed, after which 6 by 6-inch timbers are placed 3 to 4 feet apart, and the space between them filled with concrete, after which a 3-inch floor is laid. A still heavier floor of the same kind with a solid layer of concrete 2 feet thick, covered with plank on sleepers, will permit heavy machines to be set anywhere without special foundations. Such a floor was used in the erecting shop of the Allis-Chalmers plant, at Milwaukee, Wis.

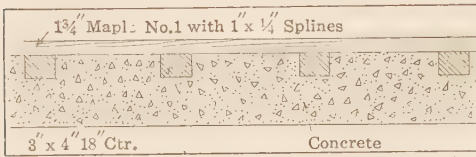


FIG. 8. WOOD FLOOR, SANTE FE SHOPS

A similar but lighter floor with 2-inch maple wearing surface and 1-inch by 1/4-inch splines, Figure 8, was used in the Santa Fe Railway shops, the maple flooring being spiked to 3 by 4-inch yellow-pine sleepers 18 inches apart, embedded in 6 inches of concrete. In this case the concrete and sleepers without the flooring cost 8 to 9 cents per square foot. In the McKee's Rocks railroad shops, wire conduits were placed below the floor at intervals of 5 1/2 feet for receiving the light and power wires for the machines (Figure 9). A layer of concrete 4 inches thick was first spread and covered with five sheets of tarred felt in hot tar, over which was spread an inch of sand. On this layer of sand, 4 by 4-inch sleepers were laid and filled between with more sand, over which was spiked a course of 2 3/4-inch pine plank, and a wearing surface of 1 1/8-inch tongue and groove maple. The railway shops at Parsons, Kan., have a somewhat sim-

No. 1, Y. P. 2 by 6 inch, tongue and groove,	costs....\$8.00 to \$10.00	per square laid
No. 1. Y. P. 3 by 6 inch, tongue and groove,	costs....13.00	per square laid
4 by 7/8 inch Y. P. tongue and groove,	costs.... 7.00 to 8.00	per square laid
6 by 7/8 inch Y. P. tongue and groove,	costs.... 5.00 to 6.00	per square laid
4 by 7/8 inch W. P. tongue and groove,	costs.... 8.50 to 10.50	per square laid
2 1/4 by 13/16 clear maple tongue and groove,	costs....11.00 to 13.00	per square laid

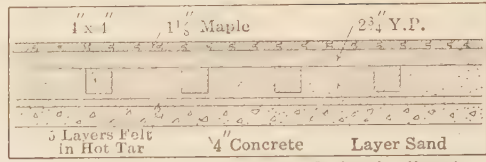


FIG. 9. RAILWAY SHOPS, MCKEE'S ROCKS

ilar floor excepting that the wearing surface is 4 by 1 1/4-inch white oak with a layer of roofing felt between the upper and lower courses (Figure 10). The 3 by 4-inch yellow-pine sleepers were treated with a zinc process to preserve them, and the space between them was filled with dry sand. They were laid on an inch of sand and tar over a 6-inch bed of broken stone. Floors of this general type with slight modifications are numerous, and show the favor with which they are received.

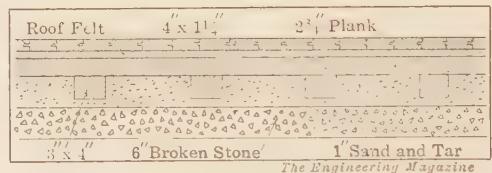


FIG. 10. RAILWAY SHOPS, PARSONS, KAS.

One man will lay 2 1/2 squares (100 square feet) per day of 8 hours on upper floors, including the hoisting, and 3 squares per day at street level. Laying sleepers costs \$4.00 to \$4.50 per thousand feet, board measure, and 3-inch flooring about \$3.00 per thousand.

FLOORS OF TAR-CONCRETE AND WOOD. An excellent shop floor consists of a base of concrete, and tar or asphalt, with a wood wearing surface. Over a mixture of tar, the wood is preserved, while over cement concrete it decays quickly, and over dead air space it succumbs to dry rot. A wood-faced floor of concrete and tar

is solid, without vibrations; tools do not break when they fall, and machines may be screwed to the floor anywhere. It is nearly fireproof because there are no sleepers and no air space beneath the wood. It is not expensive, and will last from twenty to twenty-five years, while the wood top makes it comfortable to walk upon.

It is laid by first spreading a 4-inch layer of screened gravel or stone, not larger than $2\frac{1}{2}$ inches mixed with tar. The tar should be heated to 200 degrees F., and enough added to make the mixture compact when rolled, the amount of tar in gallons per cubic yard required for different kinds of aggregate being as follows:

Stone $2\frac{1}{2}$ in. to 1 in. diam.....	6 gallons
Stone $2\frac{1}{2}$ in. to $\frac{1}{4}$ in diam.....	9 gallons
Coarse gravel.....	7 gallons
Fine gravel.....	10 gallons

The sand and gravel should be well heated before the tar is added. Over hard ground, 2 or 3 inches of tarred stone may be enough. No economy results from using cinders or sand in preference to stone for the bottom covering, for cinders require 15 gallons of tar per cubic yard, and sand 20 gallons. Stone at \$1.25 per cubic yard has, therefore, no greater ultimate cost than cinders at 50 cents per yard. In some cases, 4 to 6 inches of cement concrete is used for a base course, instead of the tar-concrete above specified, but when this is done, it should receive a coat of tar before laying the sand. Over this base of concrete is spread a 1-inch layer of sand and tar, mixed in the proportion of 50 to 60 gallons of tar to each yard

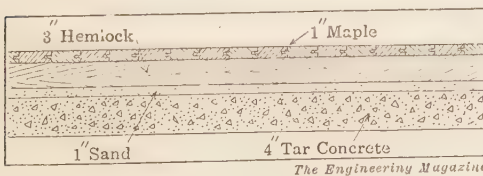


FIG. 11. WOOD ON TAR CONCRETE

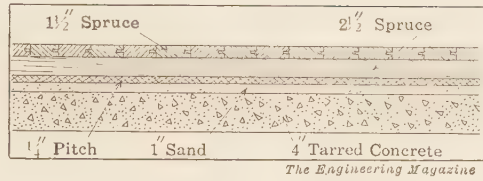


FIG. 12. BOSTON & ALBANY SHOPS

of sand. This mixture should be heated to 225 degrees F., spread $1\frac{1}{4}$ inches thick, and rolled down to 1 inch. While it is yet warm and soft, a layer of 3-inch plank is embedded therein, over which is laid a top wearing surface of maple (Figure 11).

The cost of a floor made of cinders and tar 6 inches deep, overlaid with 3-inch plank on 3 by 4-inch sleepers, 16 inches on centers, embedded on the cinders, is 8 cents per square foot for cinders and tar and 16 cents per square foot for wood.

In the above, one barrel of tar was used with eight barrels of cinders. With tar at \$2 to \$5 per barrel, the cost of these floors should not exceed 24 to 30 cents per square foot. A floor of this kind (Figure 12) in a shop for the Boston and Albany Railroad Company, with a 4-inch layer of coal-tar-concrete, overlaid with 1-inch sand and $\frac{1}{4}$ -inch roofing pitch, with two layers of spruce plank, $2\frac{1}{2}$ and $1\frac{1}{2}$ inches thick, cost in 1898 only 18 cents per square foot. Without the wood work, the cost of base with stone, sand and tar should not exceed 10 to 13 cents per square foot.

This type of floor has been used with many modifications. In one shop, cement concrete was laid 6 to 12 inches thick, with 4 by 4-inch wood strips embedded therein 2 feet apart. Over the strips and concrete was spread a layer of fine sand and coal tar, in which the lower plank course of 2-inch tongue and groove yellow pine was laid and nailed. The wearing surface in this case was 4 by $1\frac{1}{8}$ -inch maple with square edge.

Owing to the splitting of matched flooring under trucks, and the difficulty of repairing it, square-edge boards are frequently preferred for the upper course.

CEMENT-CONCRETE FLOORS. Floors of cement-concrete should be laid in the same way as a good sidewalk pavement, with cement and aggregate mixed in about the same proportion. In determining the proportion of materials for the aggregate, a barrel should be filled with broken stone, or the largest material, and the amount of water that can be added to the barrel thus filled represents the amount of gravel or fine crushed stone that it will hold. This amount of gravel and crushed stone should then be placed in another barrel, and the amount of water that can be added without increasing its bulk represents the required amount of sand.

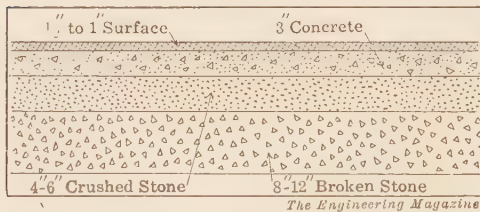


FIG. 13. CEMENT-CONCRETE FLOOR

In the same way, the required amount of sand should be placed in another vessel, and the amount of water that it can be made to hold will represent the required amount of cement. In order to have all voids in the larger material well filled by the finer ones, it is well in each case to increase the amount of finer material by about 25 per cent over the theoretical amounts found by the above tests.

One barrel of cement contains 3.8 cubic feet, and when mixed as directed above, the concrete will cover 100 square feet, $2\frac{1}{2}$ inches deep.

The depth of excavation and filling under the concrete will depend on the nature of the subsoil and local condi-

tion, as well as on the required carrying capacity of the floor, a wet soil requiring a greater depth of broken stone for drainage. A heavy floor may be strong enough to support large machines placed anywhere, while a lighter one may require special machine foundations. As a general guide for laying concrete floors, the following directions are given (Figure 13):

First, excavate the soil to a depth of 15 to 22 inches below the required grade level. Then spread a layer of broken stone 8 to 12 inches deep, over which lay 4 to 6 inches of gravel or crushed stone, thoroughly tamped and rolled. Then spread a layer of concrete 2 to 4 inches thick, which must be covered while it is still green with a wearing surface $\frac{1}{2}$ to 2 inches thick (1 inch being usual) composed of cement and sand in the proportion of one to one, or one to two. It may be colored if desired, and should be leveled off with a straight edge and marked into squares or rectangles. Shrinkage cracks will then follow regular lines instead of making irregular breaks through the pavement. The mixture for the wearing surface should be so thin that when laid and troweled off, the cement will come to the top and form a hard smooth surface when dry. It is important that the lower course be green or moist when the wearing surface is applied, for if dry, the upper course will soon crack and disintegrate. The floor should be protected for about thirty-six hours.

Instead of using 12 to 18 inches of broken stone and gravel as specified above, a depth of 5 to 6 inches may be enough in some cases for light floors and well drained subsoil, the cost of this lighter construction being 12 to 20 cents per square foot. A concrete slab 6 inches thick with $\frac{1}{2}$ -inch surface finish, supported on a

well drained base of gravel or broken stone, has been found satisfactory for round-houses, though somewhat difficult to repair.

The cost of a floor with $\frac{1}{2}$ -inch surface over a 2-inch concrete base, is as follows:

Cement	30	cents	per	sq. yd.
Stone and sand.....	10	"	"	"
Labor	26	"	"	"
Total.....	66	"	"	"

In the above, the labor cost of surface finish is 14 to 15 cents per square yard, and for a greater thickness of concrete base, the cost would be increased 18 cents per square yard for each additional inch of thickness. A light floor with 1-inch wearing surface and concrete only 4 inches thick can be laid at the rate of 100 square feet per day of eight hours for each man employed, the cost per square foot being 9 cents for materials and 2 cents for labor, or 11 cents per square foot total.

Assuming sand and gravel to cost \$1.00 to \$1.25 per cubic yard, and crushed limestone \$1.50 to \$1.75 per cubic yard, the cost of concrete may be taken at 20 to 25 cents per cubic foot, and a 1-inch surface finish at 5 to 6 cents per square foot. A 1-inch surface finish over a 6-inch concrete base, therefore, should cost 15 to 18 cents per square foot. A cement base 10 inches high and $\frac{5}{8}$ -inch thick joining the wall and floor, costs 12 cents per lineal foot in place in large amounts, and 15 to 20 cents per lineal foot for small quantities, and the labor cost of forming floor gutters is 15 to 20 cents per lineal foot. When this type of floor is used in a foundry, the finished wearing surface must be covered with 4 inches of moulding sand.

GRANOLITHIC FLOORS. Granolithic floors in shops are not very popular,

and yet as they are largely used some rules are given to aid in securing the best results. In order to discover the degree of favor with which they have been received, letters were sent a year or two ago, to a large number of factory owners, and out of forty replies received, twenty-six expressed a decided preference for wood, with only eight in favor of granolithic, while the remaining six liked the two kinds of floor equally well. As the chief objection to granolithic floors is that they rapidly convey heat away from the body and produce a feeling of weariness, it is now an established rule that these floors are suitable only when they are heated. This has been successfully done in several shops, as in the plants of the Brown Hoisting Machinery Co. and the Morse Chain Co. When these floors are not heated, employees may wear shoes with wooden soles, as is frequently done at metallurgical works when walking over hot metal, or where the floors are constantly wet.

Some other disadvantages of granolithic floors are that they are dusty and wear into ruts and hollows, especially when exposed to the action of trucks and wheels. When laid out in squares or rectangles they become chipped around the edges, and for this reason wheels should have rounded treads or rubber tires. Concrete is also chipped by heat, and in conflagrations it disintegrates for a depth of about half an inch below the surface. They need skilled and experienced men to lay them, for it only requires a little bad workmanship, poor concrete, insufficient cement, or some foreign substance such as loam, to make the floor a failure, and early breaks and disintegration a certainty. They are also difficult to repair, much more so than wood, and repairs occupy a longer time. They are not suitable for shops us-

ing edged tools, which are easily injured, and castings are liable to break by falling. In addition to these disadvantages it is difficult to attach machinery to granolithic floors.

The merits of these floors depend largely upon the care with which they are laid. They are fireproof, and are accepted as waterproof by the New York Board of Fire Underwriters. They can be washed off clean without injury and are not disintegrated by such usage. When properly laid, they are impervious to oil and are not injured by it, though oil will, of course, enter cracks which are large enough to admit it. These floors are cheaper than wood, and when heated (as can easily be effected in upper stories) they no longer have the objection of feeling cold feet and limbs.

The most approved mixture for granolithic work consists of equal parts of cement, sand, and screened crushed stone, from a size which will pass through a 20 mesh up to a maximum of $\frac{1}{2}$ inch. It is important that the crushed stone be screened to remove the dust. Some cement users prefer to omit the sand entirely, using only equal parts of cement and screened crushed stone. It should be mixed as dry as can be worked, and put down in two layers with a total thickness of about $\frac{3}{4}$ inch, the top coat being put on while the under one is wet, so they will unite. To prevent edge chipping and dust formation, the squares should be large, not less than about 20 feet, and where the floors are to be used by horses for pulling loads, the surface should be roughened. Along heavy lines of travel, wheel plates of either wrought or cast iron may be set into the floor, or a track may be made of iron grating bars on edge, filled in between with the granolithic mixture. These will prevent the floor from cracking and give horses a good foothold.

Dust formation may be avoided in several ways, the easiest of which is to give the surface a hard troweled finish. Dust may also be prevented by an occasional application of hot silicate of soda, or a wash of linseed oil thinned with turpentine or naphtha, or by painting. A method of preventing dust which is perhaps the most effective of all, is to cover the floor with battle-ship linoleum fastened with glue, using $1\frac{1}{2}$ gallons of glue per 100 square feet of floor surface.

Granolithic $1\frac{1}{4}$ -inch thick, when laid on a moist or green base, costs $4\frac{1}{2}$ cents per square foot, but when put down after the base has hardened it will cost about 7 cents.

The repairing of these floors is also important, requiring the services of skilled workmen. Main aisles or passageways, when they become worn, may be reinforced with an additional layer of granolithic over the old one. Broken edges may be repaired with a mixture of soft asphalt, the bonding being effected by heating the injured surface with a blow torch. This method is better than patching with cement paste, though not as permanent as the process described later. The most approved method of repairing is to cut away the granolithic with the sand blast or with chisels, to the bottom of the break, until the aggregate is exposed enough to give a bond. Then treat the surface with acids and wash with a hose to remove the dust, after which the surface should be covered with a thin grout. The new granolithic material should then be applied while the grout is still wet, and the patch should be kept protected and moist for about a week, when the repaired floor is again ready for use.

ASPHALT FLOORS. Asphalt floors have many commendable features, though costing more than some other kinds. They are waterproof, have no

dust, are not volatile like tar, are elastic enough to prevent crack formation, can be kept clean, and are comfortable to walk upon. They do not tire the feet of the workmen like concrete or brick and do not wear away but simply compress. They are not injured by frost or thaws, and should last at least ten years without repairs.

Rock asphalt is limestone impregnated with 8 to 17 per cent bitumen. It is made into asphalt mastic for commercial use by first grinding it to a powder and then heating it for five hours in a kettle at a temperature of 350 degrees F. with 8 per cent of Trinidad asphalt added to prevent its burning. It is then moulded into blocks weighing 50 to 60 pounds, each block having the name of the mine moulded thereon.



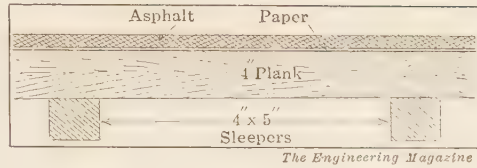
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FIG. 14. ASPHALT ON CONCRETE

It is prepared for floors by mixing it with Trinidad asphalt and sand in the following proportions: By weight of 60 per cent broken mastic blocks, 4 per cent Trinidad asphalt, and 36 per cent fine gravel and sand.

The mixture is then heated to a temperature of 300 to 400 degrees F. for about five hours, and constantly stirred, after which it is taken out and spread on the floor to a thickness of 1 inch. It is then covered with sand and rubbed to a smooth finish. A base for this floor may consist of a layer of concrete 3 to 4 inches thick (Figure 14), or a course of plank on sleepers, the plank being overlaid with tarred felt or sheathing paper (Figure 15). Asphalt is also moulded into paving blocks 4 by 4 by 12 inches, and when laid with these blocks, floors are more easily repaired.

Asphalt has several imitations



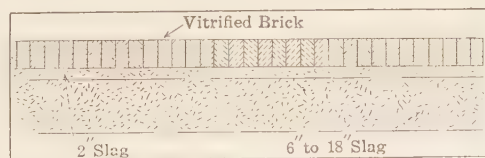
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FIG. 15. ASPHALT ON PLANK

made of tar and crushed limestone which are of poor quality, for like other tar products, the tar evaporates and the floor cracks. Asphalt floors are not suitable in shops where oil collects or drips, for the asphalt is softened and destroyed by oil. A 1-inch floor without the base costs from 16 to 18 cents per square foot.

BRICK FLOORS. A fine basement floor over dry soil is made by first placing a 12-inch layer of well compacted sand rolled and leveled, over which a course of brick is laid flat, and on this another layer of brick on edge, both courses being jointed with cement mortar and grouted full.

The floors of foundry pits should have two layers of brick over a 6-inch concrete base, and the pit walls should be one brick or 8 inches thick, all laid in cement mortar. For boiler-house floors the bricks may be laid flat with diagonal joints, giving a pattern effect. There is no better floor for round-houses than brick, for when injured they are easily repaired. The pressure of heavy jacks and the rolling about of trucks and wheels has been found to cause frequent breakage to round-house floors, and when made of brick they can be easily replaced by removing only a small portion. Wood floors in round-houses wear out too quickly, and concrete cracks and disintegrates under



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FIG. 16. BRICK FLOOR

heavy loads. A timber base should be avoided, which for repairs would necessitate the removal of a larger area.

The ground should be excavated to a depth of 8 inches and should then be well rammed, all alluvial soil being removed and depressions filled up with sand and gravel. A 4-inch layer of sand should then be spread and tamped, after which hard bricks are laid on edge. If a waterproof floor is needed, the bricks should be grouted and covered with tar. As slag and cinder usually cost the railroad company nothing, they are frequently used as a bed for these pavements instead of sand and gravel. (Fig. 16.) The floors of engine pits should be crowned 2 inches at the center for drainage, and the walls should be capped with timber at each side of the pit. These floors usually cost from 85 cents to \$1.15 a square yard.

Recommended Types.—The types of floor which have been found from experience to be the best for shops of different kinds are given in the following tabulation:

Annealing rooms.....	Brick or cast-iron plates.
Car shops and car houses.....	Concrete base with granolithic finish.
Cleaning rooms.....	Cast-iron plates.
Cupola floors.....	Inverted steel channels, rough rolled or cast-iron plates.
Forge shops.....	Earth or cinder floors.
Foundry pouring floors.....	Cast-iron plates or brick on plank and sand.
Moulding floors.....	Concrete or brick.
Machine shops.....	Creosoted wood-blocks or plank on concrete base.
Offices	Maple or yellow pine on sleepers over concrete.
Power house, Engine rooms.....	Concrete with cement or tile finish.
Power house, Boiler rooms.....	Concrete with cement or brick on edge.
Toilets	Concrete with cement finish.
Wash rooms.....	Concrete with cement surface.

The above are the recommended types, though in some cases, such as round-houses and machine shops, preference and practice has a considerable variation. Round-house floors have received much attention from

the railroad companies and several types are extensively used, including cinders on clay, plank, brick, and concrete. These floors receive very hard usage from hydraulic jacks and the removal of trucks and other parts, and a floor of vitrified paving-brick is usually preferred; for, as previously stated, when damaged it can easily be repaired by removing only the injured part. The repairing of timber or concrete floors is more difficult, for a larger area must be taken up. Wood blocks lack resistance, and when laid over planks they are subject to the same objection as other timber floors.

Machine-shop floors have been widely experimented with. They usually receive hard service, especially in erecting shops where loads are dragged along the floor by the lifting cranes, and machinery parts are piled up high, subjecting the floors to heavy weight. Brick, concrete, and asphalt conduct heat away from human bodies and are therefore uncomfortable, and sharp-edged tools

are injured by falling on such hard surfaces. Grit and dust rising from them, are injurious to machines, especially in the bearings. For these reasons, some kind of wood floor is usually preferred.

WORKMEN'S COMPENSATION IN EUROPE AND AMERICA

By Mancius Smedes Hutton

Legislation directed toward larger and surer compensation of workers against accident or disease incident to their calling is active everywhere. Conditions long suffered are satisfactory to no one, unless it be a certain class of lawyers. Action by legislatures is certain to be taken. The great desideratum, for employers as well as employees, is to have the action right. One valuable guide is the study of measures already tried, and of their result. Mr. Hutton deals principally with European experience and Federal Statutes in the United States. Elsewhere in this issue will be found a review of a detailed synopsis of acts passed in the individual States of the Union.—THE EDITORS.

TWENTY-SIX years ago last October (October 1, 1885) Germany put in effect the first workmen's compensation law ever enacted by any country. Since that time nearly every country in Europe, with the exception of Switzerland, has enacted compensation laws, thereby taking off the statute books the common-law doctrine of employers' liability which experience has shown to involve uncertainty, delay, and expense.

Below is given a list of the countries, in chronological order, which have passed compensation acts:

COUNTRY	DATE OF ENACTMENT	DATE LAW WENT INTO EFFECT
Germany	July 6, 1884	Oct. 1, 1885
Austria	Dec. 28, 1887	Nov. 1, 1889
Norway	July 23, 1894	July 1, 1895
Finland	Dec. 5, 1895	Jan. 1, 1898
Denmark	Jan. 7, 1898	Jan. 15, 1899
Italy	Mar. 17, 1898	Sept. 17, 1898
France	Apr. 9, 1898	July 1, 1899
Spain	Jan. 30, 1900	July 28, 1900
Netherlands	Jan. 2, 1901	June 1, 1901
Sweden	July 5, 1901	Jan. 1, 1903
Russia	June 15, 1903	Jan. 14, 1904
Belgium	Dec. 21, 1903	July 1, 1905
Great Britain	Dec. 21, 1906	July 1, 1907
Hungary	Apr. 9, 1907	July 1, 1907

Besides these countries the following States and colonial possessions have also compensation laws:

Alberta, British Columbia, Cape of Good Hope, Greece (law applies to mining only), Luxemburg, New South Wales (law applies to mining

only), New Zealand, Quebec, Queensland, South Australia, Transvaal, West Australia.

In Belgium and Great Britain the laws apply to practically all employment; in Australia, Denmark, Finland, Germany, Italy, Luxemburg, Netherlands, Norway, Russia, Spain, and Sweden to wage earners only, but, in some cases, overseers and technical experts come within the scope of the law. On the other hand, in France, Great Britain, the British Colonies, and Hungary, the laws apply to salaried employees and workmen alike.

Overseers and technical experts earning more than a prescribed amount are excluded in Belgium, Denmark, Germany, Great Britain, Italy, Luxemburg and Russia. Employees of the State as well as provincial and local officials usually come within the provisions of the act.

As there is in many minds a confusion between the common-law doctrine of employers' liability and the workmen's compensation acts, it is necessary that a definition be given to each of these terms.

The employee has the right of action under the common law against the employer in cases where injury from accident results as a consequence of the negligence of the employer or of someone charged with

the performance of his non-delegable duties. Contributory negligence is present when the injured employee contributes by his own negligence to cause the accident, and such negligence bars recovery. It is understood that the employee assumes all ordinary risks incidental to the employment and no recovery of damages can be had for injuries resulting therefrom.

In a majority of cases, after the workman has sued his employer for damages under the above law, the amount of damages he recovers from the court has been so eaten up by the lawyer's fees that he receives only about 20 to 30 per cent of the amount awarded. Besides this, there is the delay incident to the award, so that quite often it has been a year or more before he receives his money, although the time he needed his money most was the time of the accident or immediately afterwards.

Under the compensation acts the employee receives a definite sum of money for accidents for which the employment is responsible, without the necessity of going to court to determine the question of fault. It is provided frequently that where an employer is apparently grossly negligent, damages can be recovered in addition to the compensation, while, on the other hand, if the employee should be wilfully or grossly negligent he will be debarred from receiving compensation.

The laws, in every case, fix the compensation to be paid at the time of the accident, and with but one or two exceptions the compensation is based upon the wages received by the injured person. It consists of allowances for temporary disability, and annual pensions or lump-sum payments for permanent disability or death, to which are frequently added the expenses of medical and surgical

treatment, and in some cases a funeral benefit.

The entire burden rests upon the employer in all but six countries—Austria, Germany, Greece, Hungary, Luxemburg, and New South Wales, where the employees bear part of the expense.

European countries have found the compensation act of little use, unless obligatory insurance guarantees the compensation awards to the injured workmen without overburdening the small employer. Therefore, many forms of insurance plans are found in the various countries. Without going too deeply into the different schemes, they can be divided into two large classes, compulsory and voluntary; and again, each can be divided into two sub-classes; (a) compulsory insurance in prescribed institutions, (b) compulsory insurance with choice of insurance institutions. Under the voluntary insurance there are (c) private companies or mutual associations, with State institutions competing; (d) private companies or associations, without State institutions competing.

In a general way, the following countries come under these four heads:

COMPULSORY INSURANCE:

(a) Norway, Luxemburg, Hungary, Germany, and New South Wales.

(b) Italy, Netherlands, and Finland.

VOLUNTARY INSURANCE:

(c) Sweden and France.

(d) Belgium, Denmark, Great Britain and her colonies, Russia, and Spain.

It is not the purpose here to go too deeply into the various European laws, but to take the German and English laws as typical cases and to call attention to some of their special features.

COMPENSATION LAW OF GREAT BRITAIN

In the table given above the dates are those of the first enactment except in the case of Great Britain, where the first compensation law was enacted in 1897. The scope of this law was enlarged in 1900 to include agriculture. Four years later an investigating committee was appointed to determine the defects in these acts. As a result of the work of this committee, Parliament passed the law of 1906 which superseded the acts of 1897 and 1900. The substance of this law is given below.

Compensation can be obtained, if an accident arising out of and in the course of employment causes death or such personal injuries as prevent the workman for at least a week from earning full wages at the work at which he is employed. Where the injury was due to the serious or wilful misconduct of the workman, compensation is not paid unless such misconduct results in death or serious and permanent disablement. If the employment is of a casual nature no compensation will be paid; otherwise any person regularly employed in any of the industries, whose earnings are less than £250 (\$1,216), can obtain compensation in case of injury. This act also includes civilian persons employed by the government. The entire cost rests upon the employer.

Occupational diseases were legally considered as accidents, and the act mentioned six and gave power to the Secretary of State to add other ones from time to time at his discretion.

In order to claim compensation under this provision of the act, the workman must have been suspended from his work on account of having contracted such disease, or it must be certified by the district surgeon that the workman is unable to earn full

wages on account of his having one of the enumerated diseases, or it must be shown that death was caused by such disease.

The amount of compensation awarded the workman for death and disability is as follows:

DEATH.

(a) A sum equal to three years' earnings, but not less than £150 (\$730) nor more than £300 (\$1,460) to those entirely dependent on earnings. Partial dependents to receive a less sum than the above, the amount to be agreed upon by the parties or fixed by arbitration.

(b) Reasonable expenses of medical attendance and burial, but not to exceed £10 (\$48) if deceased leaves no dependents.

DISABLEMENT.

(a) A weekly payment during incapacity of not more than 50 per cent of employee's average weekly earnings during a previous twelve months, but not exceeding £1 (\$5) per week; if incapacity lasts less than two weeks no payment is required for the first week.

(b) A weekly payment during partial disability, not exceeding the difference between the employee's average weekly earnings before injury and the average amount which he is earning or is able to earn after injury. Minor persons may be allowed full earnings during incapacity, but weekly payments may not exceed 10 shillings (\$2.43).

The act does not state any association or company in which the employer has to insure but leaves this question open. He may make a contract with his employees for substituting a scheme of compensation, benefit, or insurance in place of the provisions of the act, provided it is not less favorable to the workmen and their dependents and it is concurred in by the majority of the workmen. Such schemes must be certified by the Registrar of the Friendly Societies.

In case the employer should become bankrupt, the amount of compensation due under the act in any individual case, up to £100 (\$486), is classed as a preferred claim. The claim for compensation must be made within six months after the

occurrence of the accident or the date of death therefrom, and the employee or his estate may enforce it at any time they please.

Notice of the accident must be sent by the employer to the inspector of the district, and to its certified surgeon, when the injured employee has been disabled in such a manner that he has been absent from his ordinary work throughout one whole day.

Disputes that may arise between the employer and his workman in regard to questions pertaining to the act are settled by one of three methods: (a) by a committee representing the workman and the employer, (b) by an arbitrator selected by both parties, (c) by the judge of the county court or by an arbitrator appointed to act in his place.

This will give a fair idea of the British Compensation Law of 1906. There has been passed by Parliament (1911) The British Insurance Bill. This bill is patterned after the German sickness and invalidity insurance. It has been fathered by Mr. Lloyd George, the Chancellor of the Exchequer. This law has not gone into force as yet.

GERMAN COMPENSATION LAW

The first accident-insurance law was enacted in 1884, under the leadership of Prince Bismarck, and went into effect the next year. Since that time additions have been made and two other insurance schemes have come into existence, one of which is known as the sick-insurance and the other as the invalidity-insurance. These three were combined into one code by the law of July 19, 1911, which will not be put into force until January 1, 1913. There has been no attempt in the new code to consolidate the organizations conducting the several insurance funds above referred to,

ACCIDENT INSURANCE

This insurance includes only those accidents which are defined as sudden unforeseen occurrences which cause maiming and incapacitate the victim physically. The time when the accident happened must be his working hours. The injury must cause the absence of the workman from his work for more than three days. The injury must not have been incurred intentionally or while committing an illegal act. All workmen and those technical officials whose annual earnings are less than 5,000 marks (\$1,190) are entitled to all the provisions of the law if working in the following trades: mining, salt works, quarrying and allied industries, factories, shipyards, metallurgical and metal-working plants, pharmacies, breweries, tanneries, decorating, stone-cutting, locksmithing, blacksmithing, stone-breaking establishments, chimney sweeping, window cleaning, butchering trades, transportation, inland navigation, ice cutting, rafting, ferries, fisheries, agriculture, and forestry. The government employees of the postal, telegraph, and railway service and those working in the industrial enterprises of the army and navy are also included. The insurance for these is paid for by the Federal government. The rest of the workmen receive their compensation through the accident-insurance associations which are called "trade associations" since they are composed of the employers of each of the various trades. In some trades there may be several of these associations, representing the same trade but located in different parts of the country. Each employer, according to the law, must insure his employees in his nearest trade association.

The compensation for death and disability is as follows:

DEATH.

(1). Funeral benefits of one-fifteenth of the annual earnings of the deceased, but not less than 50 marks (\$12).

(2). The dependent heirs receive pensions which must not exceed 60 per cent of the annual earnings of the deceased. The widow receives 20 per cent of annual earnings until death; if she should remarry then she receives a lump sum equal to three annual payments. The widower receives 20 per cent and each child under 15 years of age, 20 per cent of the annual earnings. If there is a residue after providing for the above heirs, then the heirs in the ascending line receive pensions.

(3). If annual earnings exceed 1,800 marks (\$482) only one-third of excess is considered in computing pensions.

DISABILITY.

(1.) Free medical and surgical treatment paid for first thirteen weeks by sick-insurance funds, and afterwards by the accident association. This includes medicines, crutches, braces and other therapeutic appliances.

(2). For total disablement, two-thirds of the worker's annual earnings. The person may be granted the regular sick and pecuniary benefits for thirteen weeks. The pecuniary benefits shall amount to two-thirds of the basic wage. If there is a loss of earning power after thirteen weeks, then a pension is paid at the time the pecuniary benefits stop. If the person is not insured in a sick fund, the trade association must give him the same benefits that he would receive if he was insured.

(3). If the person is completely helpless, needing medical attendance, the payments may be increased to 100 per cent of the annual earnings.

(4). For partial disablement a reduction is made in the above payments.

(5). If the annual earnings exceed 1,800 marks (\$428) only one-third of excess is considered in computing pensions.

Before taking up more in detail the sickness and invalidity insurance, it may be worth while to tell about the work which these trade associations are doing besides handling the premiums paid by the employers.

There are sixty-six industrial and forty-eight agricultural accident associations. They are self-governing bodies under the supervision of the Imperial Insurance office. It will be quite evident that an association whose members are the employers

would naturally be very much interested in the question of how they can reduce the amount of the premiums. This leads to the study of safeguards in the various trades by these associations. In order to promote the use of guards among the members they employ expert safety inspectors who give the employers free advice as to how they can reduce the accidents and sickness among the employees. These inspectors issue a yearly report covering their work. Besides this, the associations publish pamphlets and books describing safeguards and preventive methods as well as rules and regulations to be used in the different industries.

A committee representing the combined associations have published (1911) a book (*Unfallverhütung und Betriebssicherheit*) describing safeguards which they have found to be the most practical during twenty-five years' experience in the different trades.

The German employer has believed for the past twenty-seven years in the epigram which says that "Every life saved is a national asset." Therefore he has co-operated with his association and the government in anything which will conserve the lives of his workmen. It has been for this reason that the employer has been willing to tell all about his accidents to his association. This has given Germany the most complete statistics covering the longest period of years of any country in the world. These statistics are published yearly by the Imperial Insurance office. The employers are compelled by law to notify their association at the time of the accident.

SICK INSURANCE

This insurance is compulsory for workers in the industries, trades, and handicrafts; also notarial and lawyer's clerks, those occupied in

hospitals, trade associations and insurance institutions, household servants, clerks and apprentices in pharmacies, members of orchestras, theatrical companies, teachers, persons in home-working industries, ships' crews of sea-going vessels, and crews of vessels engaged in inland navigation. There is also a voluntary insurance for those whose yearly income does not exceed 2,000 marks (\$595) and who do not come under the above list.

This insurance provides three kinds of benefits, namely, sickness, maternity and funeral. The first of these includes medical attendance and supplies of medicine, eyeglasses, trusses and other minor therapeutic appliances, from the time of the beginning of sickness until the end of the twenty-sixth week, which period may be extended to one year. There is also a pecuniary benefit fund. Instead of medical care, the fund may grant treatment and maintenance at a hospital. If the insured is supporting dependents either wholly or partly from his earnings, there will be paid such dependents a sum equal to a half of the pecuniary sick fund.

The maternity benefit gives to women lying-in a pecuniary sick benefit for eight weeks, six of which must fall in the period after confinement.

The funeral benefit has been noted above.

There are other benefits to be derived from this group which are too long to narrate here.

There are under the new code five different sick funds, which are managed by a group of men who do the work of management without salary. In this group are representatives of the insured workmen and the employers in the ratio of two-thirds of the former and one-third of the latter.

The employer pays one-third and the workman two-thirds. The employer pays the premium and deducts the workman's share from his wages.

During the time the patient is sick no contributions need be paid towards the fund.

In the voluntary insurance the insured pays the whole amount to the fund and the employer pays nothing.

The organizations employ their own doctors and make arrangements with certain hospitals and sanatoriums to handle their patients.

INVALIDITY INSURANCE

The persons covered by this insurance are the same as those mentioned before under the sick insurance. There is also a voluntary insurance plan.

Before he is able to obtain the pension, the insured person must have become an invalid through sickness or infirmity, and he must not be able to earn more than one-third of the amount which a normal person of similar training and status in life is able to earn. An old age annuity is paid after the completion of the seventieth year of the insured without regard to his physical condition.

The invalid or non-invalid widow of an insured person receives a pension as long as she remains unmarried. The orphans of insured persons, if under fifteen years of age, receive a proportion of the invalidity pension of the deceased. After the child has completed its fifteenth year it receives a sum equivalent to eight times the monthly amount plus 16 2-3 marks (\$4). The widow and the young child receive also an Imperial subsidy.

The insurance is conducted by organizations which are directed by committees consisting one-half of employers and one-half of insured

persons. The government, either State or local, appoints the officials who conduct the affairs of these organizations. Contributions are paid one-half by the employer and one-half by the insured person, while the Empire annually grants a subsidy of 50 marks (\$12) to each pensioner.

CONCLUSIONS

The statistics for the last twenty-five years show that of the money turned into the different organizations on account of the accident, sickness and invalidity insurance, there has been paid out 72 per cent in the various forms of compensations or pensions; $20\frac{3}{4}$ per cent has been turned into a reserve fund, and $7\frac{1}{4}$ per cent has been charged up against administration expenses. Of the 72 per cent of compensation, 40 per cent was raised by the workmen themselves. The work people received \$1,918,000,000 out of a total of \$2,663,000,000. The employer during the same period has paid towards the various insurances \$535,000,000 more than the employees, who paid \$1,064,000,000 towards their own insurance. Stated in another way, the German employers have yearly given \$64,000,000 and the workman \$42,500,000 during the last twenty-five years to the insurance of the employees.

Even with this great expense placed on both employers and employees, they have made no attempt to change the law radically but instead have enlarged its scope.

The reason why the administration expense is so low and the compensation paid so high is because (1) the associations and organizations are carried on a mutual basis, making no profits for stockholders nor paying any commissions to solicitors; (2) their officers devote their time and give their experience without pay.

UNITED STATES COMPENSATION LAWS

Passing now from Europe to America, an examination will be made of the State and Federal compensation laws of the United States.

The first State to depart from the doctrine of liability and proven fault was Maryland. The co-operative insurance law of 1902, which applied only to mining, quarrying, and steam and street railways, provided for contributions from the employer, who could recoup himself to the extent of one-half of such contribution from the wages paid the employee. Massachusetts the next year appointed the first legislative commission to draft a law on compensation, but it was never passed.

A compensation law in its true sense was passed by the United States Philippine Commission in 1906 and applied to all employees of the insular government, including laborers. This was followed two years later by an act of the Federal government which applied to those working in any of the government manufacturing plants, arsenals, navy yards, in the construction of river and harbor or fortification works, on the construction work in the reclamation of arid lands, and those in the employ of the Isthmian Canal Commission. The same year Congress passed a compensation law applying to those engaged in interstate commerce, but this law was declared unconstitutional by the Supreme Court of Connecticut. It was appealed and the decision has now (1912) been reversed by the United States Supreme Court.

There was passed at the last session of Congress a joint resolution, which was approved by President Taft, calling upon him to appoint a commission consisting of two members of each House and one member to be selected by the President. This com-

mission was to make a thorough investigation of the subject of employers' liability and workmen's compensation and to report back at this session of Congress the draft of a compensation bill to apply to those employees engaged in interstate commerce. This bill was submitted to Congress on February 20, 1912. President Taft sent a special message, on that date, urging the passage of the bill, which is considered the most advanced piece of liability legislation yet presented.

This proposed bill considers the burden of payment for personal injuries as an element of the cost of transportation, and directs the Interstate Commerce Commission to recognize and give effect to this policy.

The amount of compensation for death or disablement is as follows:

DEATH.

The monthly payments are to be made for eight years thus:

A widow alone receives 40 per cent of the monthly wages; a widow and a child under sixteen receives 50 per cent; a child, alone, under sixteen, 25 per cent, and 10 per cent for each additional child. If the widow dies or remarries within the eight years, payments are to be continued to the children, if any, for the unexpired period. If there is no widow nor children, then 15 per cent is given to partially dependent parents and 20 per cent to one wholly dependent parent, or 40 per cent if both parents are dependent. In the absence of these dependents, provisions are made for brother, sister, grandparent, or grandchild as dependents.

DISABLEMENT.

For permanent total disablement, the employee receives 50 per cent of the monthly wages for life, and he obtains the same amount during the time he should be temporarily totally disabled. For the loss of an arm, leg or thumb the payments are to be continued for the following number of months: Seventy-two, sixty-six and thirteen, respectively. For the loss or impairment of other parts of the body, the payments will be according to the ratio of its effect upon the earning power of the person.

No payments are to be made while the employee is at work at wages amounting to 90 per cent of those he received at the time of his injury.

The bill has not been acted upon by either the House of Representatives or the Senate. If it should pass, it has been estimated that it will cost the railroads of the United States about \$15,000,000 a year, which will be 25 per cent more than the sum the railroads are now paying for accidents to their employees.

In the year 1910 New York State passed a compulsory compensation law. The law practically eliminated the assumption-of-risk doctrine; it went much farther in limitation of the fellow-servant rule, and as respects contributory negligence the employer was compelled to prove positively that the workman was guilty of negligence in order to avail of this defence. Previously, the workman had to prove that he was not himself negligent in order to make his employer liable. The law was drawn to compel the employer to prove that the employee was negligent in order to escape liability.

The amount of compensation paid under this law was, for disability, one-half of the wages, beginning two weeks after the accident, but not to exceed \$10.00 per week, and not to continue for more than eight years from the date of the accident. For death, the compensation was to be four-years' wages or twelve hundred times the daily wage, but not to exceed \$3,000 in any case.

This law was declared unconstitutional by the State Court of Appeals.

In the same year there was passed an optional compensation bill, which had the same provisions as the compulsory but making it entirely optional on the part of the employer or employee to accept the provisions. This law is still on the statute books of New York State.

This was one of the first States to pass a compensation law, and it was a great blow to other State commis-

sions to have it declared unconstitutional.

At the end of the year 1911 fourteen States had passed laws which had either elective compensation or State-insurance features. The States having the elective compensation are California, Kansas, Minnesota, New Hampshire, New Jersey, New York, Nevada, Illinois and Wisconsin, while Maryland, Massachusetts, Montana, Ohio and Washington have the insurance scheme. Maryland and Montana laws refer only to the coal-mining industry. The laws of Massachusetts, Washington, and Wisconsin have been declared constitutional by their State supreme courts.

Missouri had a commission appointed in 1910, which has not reported as yet to the legislature. During the year 1911 the following States appointed commissions: Colorado, Connecticut, Delaware, Iowa, Michigan, North Dakota, Pennsylvania, Texas, and West Virginia. In none of these States have the commissions given an account of themselves.

An elective compensation act is one in which the employer has the choice of voluntarily accepting the provisions of the act or of working under the common law, but it is made to the advantage of the employer to choose to work under the act, since the two defences which gave him the best chance to win his suit against his employee, namely:

- (1) That the employee assumed the hazard of the occupation (assumption of risk);

- (2) That the injury was caused by the negligence of another employee engaged in the same employment (fellow-servant rule)

were stricken from the statute books, leaving the employers' defences only:

- (3) That there was no negligence or want of ordinary care on

the part of the employer (negligence);

- (4) That there was negligence or want of ordinary care on the part of the employee (contributory negligence).

Investigation showed that nearly three-quarters of the suits brought before the courts had for their defences the first two. Considerably less than a quarter used the third defence, while it was very hard to prove the fourth defence.

In some of the States the last defence is abrogated and one of comparative negligence substituted. Each State law is a little different in one form or another in regard to the last two defences, but every State has taken away the first two defences.

By the elective compensation act the employer in whose factory the accident happens bears the full financial burden, while in the insurance scheme every employer electing the law contributes *pro rata* to an insurance association or company, thereby distributing the losses. In the compensation plan the one who has no accidents carries no burden of compensation, while in the insurance system he bears a share of the compensation to be paid through the entire range of industry, no matter what accidents he has in his own works.

In the insurance plan, as in the compensation laws, the first two defences enumerated above have been also taken away from the employer.

In all the States with the exception of Ohio, the employer is the sole contributor. In the latter State the employees may be assessed 10 per cent of the insurance. New Jersey, California and Wisconsin have appointed commissions or "Industrial-Accident Boards" as they have been sometimes called, to whom all questions brought up in connection with the new laws have been referred. The boards are

to locate any defects in the laws, so that they can be called to the notice of the legislature for such correction as may be advisable. They are also to call the attention of the employers and employee to the advantages to be obtained by choosing to work under the law. Besides this they call the attention of the employers to the necessity of safeguarding their works with proper safeguards.

The laws passed during the year 1911 in the case of California, Kansas, Massachusetts, Nevada, New Hampshire, and Ohio provide that the compensation for the death of the workman shall be equal to three-years' earnings. In New Jersey it is 25 to 60 per cent of the three-years earnings, according to the number and relationship of the dependents. In Illinois and Wisconsin the amount is equivalent to four-years' earnings, while in Ohio it is 66 2-3 per cent of the average weekly wages for six years. In the above States the dependents receive anywhere from \$1,000 as a minimum to \$5,000 as a maximum, with the exception of Massachusetts, which has \$620 as its minimum. If there are no dependents, then the estate receives between \$100 and \$300. Funeral expenses are provided in the Ohio and Washington laws. All these States, with the exception of Kansas, Nevada, New Hampshire and Washington, provide medical treatment. The compensation for total disablement in these States is between the limits of 50 and 66 2-3 per cent of the weekly wages which do not fall or rise above a stated weekly sum (\$4 to \$15) to be paid for a term of years (three to fifteen). The insurance systems of Ohio and Washington have no time limit. Wisconsin provides that if the person is so helpless that he requires a nurse, then his compensation shall be 100 per cent of his weekly wages.

Compensation for partial disablement is a certain percentage of the weekly wage loss, being the same in nearly all cases as that for total disablement, with the same limitations as to the term of years and maximum weekly payments. Each State law differs slightly from the above; but this gives a general idea of the amount of compensation which the injured person receives according to the latest State laws.

Within the last year or so a number of prominent firms, corporations, and associations of manufacturers have instituted relief among their own employees. These include compensation in case of accident or sickness, and long-service annuities. Among such are the United States Steel Corporation, and several of the independent steel companies, International Harvester Co., Cheney Brothers, Pennsylvania Railroad Co., etc. The following associations, whose members are employers of labor, have used their influence to have a relief scheme which they drafted used by their members: National Metal Trades Association, National Electric Light Association and the Brewers' Association. Besides these, the National Civic Federation and the American Federation of Labor have drafted compensation bills which they are advocating before the State commissions and the Federal Government.

OCCUPATIONAL DISEASES

The State of Illinois appointed in 1910 a commission composed of physicians, surgeons, and factory inspectors, who studied the occupational diseases occurring in twenty-eight different trades of the State. The poisons studied were lead, arsenic, brass, zinc, turpentine, carbon monoxide, potassic cyanide, silver nitrate, hydrofluoric acid, and the

chromates. The commission noted what effect the presence of these poisons had on the workers who came in contact with them. They tabulated the number of cases of disease which they found, to determine how prevalent they were, and also whether in any of the factories the employer had taken means to lessen the number. They issued a report of their findings in book form.

As a result of this investigation the legislature during 1911 in five States—California, Connecticut, Illinois, New York, and Wisconsin—passed bills requiring physicians to report back to the State Board of Health or the Commissioner of Labor (or both) cases of occupational diseases which should come under their notice. This is the first effort made by any of the States, with the exception of Illinois, to determine the number of cases of anthrax, compressed-air illness, lead, phosphorus, arsenic and mercury poisoning occurring in these States.

The Federal Government has before it at this session of Congress the Esch Phosphorus Match Bill, which if it passes will prohibit the manufacture and sale of white-phosphorus matches. The manufacture of these causes that loathsome disease called "phossy jaw" which attacks and corrodes the bony part of the jaw. Already Germany, Denmark, France, Luxemburg, The Netherlands and Switzerland have signed an agreement at Berne (on September 26, 1906) to which Italy, Great Britain, and Spain, including the colonial possessions of these countries, have signified their adhesion, the agreement being that these countries would not

manufacture the deadly white-phosphorus matches.

Considering that this humanitarian movement in the United States started only a short time ago, it is surprising what great strides it has taken within the last few years. It is not too much to expect that it will take greater strides in the years to come. With the coming of the laws on compensation for injured workmen, has come the very broad question of safeguarding workmen from accidents. Practical accident prevention has become an established fact in the United States. State and government officials, as well as the employers and casualty companies, are making a study of safety devices, and the result of their study has borne fruit by the lessening of the number of accidents in certain factories 50 to 60 per cent.

Further data of British and Continental laws may be found in the twenty-fourth annual report of the United States Commissioner of Labor.

The new German code is given in the Bulletin of the United States Bureau of Labor for September, 1911 (No. 96). The English and German laws are fully explained in the book entitled "Accident Prevention and Relief" by Ferd. C. Schwedtman and James A. Emery published by the National Association of Manufacturers. For the American laws reference may be made to the Bulletin of the United States Bureau of Labor (No. 90) for September, 1910, and Vol. I, No. 3 of the American Labor Legislature Review, published by the American Association for Labor Legislation.

MODERN ORGANIZATION

VII. THE GENESIS AND REVELATION OF ORGANIZATION

By Charles DeLano Hine

Major Hine's definition of his philosophy of management began in our first issue for the year 1912, with a concise explanation of the "unit system" of organization as applied on the Harriman Lines. From thence he proceeded to make clear the reasons for the effectiveness of the measures adopted in his system, and next to apply his interpretations to the main factors and relations of modern management—especially to the problems of centralization and of the relations of line and staff functions.

His policies are highly interesting because they depend so little upon mechanisms of any kind, so little upon systems affecting the rank and file or the equipment and *materiel*, and so much upon psychological influences operating first upon and then through the directing official. They are policies largely of mental suggestion; and mental suggestion must be the final power, the ultimate effective appeal, in any successful philosophy of management, whether "traditional", systematic, or scientific. For mental suggestion creates and transforms the ideals which are the first principle of efficiency. We reach the conclusion of Major Hine's series with regret, tempered by the pleasure of the expectation of publishing the complete group in book form immediately.

—THE EDITORS.

ORGANIZATION is a necessity and not an accident. Organization exists in response to some need of the social order. The type of organization adopted, however, is often accidental and frequently unscientific. There are so many more men who know how than there are who know why, that departures from sound principles should be expected, rather than otherwise.

The first type of organization encountered among all peoples is that of the family, well termed the unit of civilization. This organization is scientifically sound because based upon natural laws. The evolution of this organization is from polygamy to monogamy. At first, the family served all purposes of organization. As new generations came, as populations increased, the distinct limitations of the scope of the family organization necessitated a still larger unit, such as the tribe or the clan. Whenever precedents are lacking any new organization is characterized

by rule by the strongest. Thus it happens that despotism alone is able to hold together the more or less heterogeneous elements which have been grouped together to carry out an undertaking.

Gradually, as the component elements crystallize along more or less definite axes of activity, there come demands for protection in the enjoyment of positions attained. In government such demands eventually result in charters of liberty, in guarantees of protection to person and property, in constitutions written and unwritten, and in various other forms of checks and balances. Such organization should be scientific, since it is based upon the practical necessity of checking the natural caprice of those invested with authority and power. Governmental organization, however, is usually more scientific than practically effective. It accomplishes the general purposes in a highly satisfactory manner, but at an enormous and ex-

travagant money cost. The inherent defect is the difficulty in checking the public official effectively, and at the same time leaving him a balance of initiative and defined responsibility. There is always the sub-conscious fear that the public official will be too powerful.

Government thus differs from other corporations in having its stockholders, the citizens, holding back the duly constituted officers. In most other corporations the proposition is reversed. The stockholder is so fearful that the duly elected officers of the corporation will not produce maximum financial returns that he usually leaves such officers untrammelled and, perhaps, unchecked.

Here are two extremes between which must be fixed a more or less indefinable happy medium. That such medium is being scientifically sought is evidenced, on the one hand, by the growth of commission forms of government, and, on the other, by the increasing interest of stockholders and directors of large corporations in the performance of their officers. The student of organization as a science finds much cause for optimism in contemporaneous developments.

The casualist finds a world of chance in which accident and luck play the leading parts. The scientist, in whatever branch, including organization, finds a world of universal law with every recognized cause producing a corresponding effect. There is no greater evidence of the advancement of mankind than its willingness to discuss subjects of every nature. Previous failures to consider organization as a science may be traced to the same fundamental misconception of individual rights and moral delicacy as has characterized consideration of the science of eugenics. Time is the best regulator

of all great questions, because it permits the operation of the fundamental of all laws, that of supply and demand. Organization and eugenics are supplying a demand of a rapidly advancing world for a better grouping of better men and women.

Mankind is prone to mistake the shadow for the substance. Just at present the efficiency of the modern corporation is measuredly decreased by the snap judgment of the financial centers upon too short periods of performance. This condition is reflected in weekly or monthly statements of gross earnings and of net earnings. Efficiency is judged by seeming ability to make a better showing than was made in a corresponding previous period. The result is that subordinate officers are tempted to strive for a paper showing rather than to conduct and conserve along the broadest lines the property entrusted to their charge. For example, the man in the street in New York may judge the efficiency of a western railway by the size of its trainload in a given month or year. Perhaps the apparently wonderful showing has been attained by excessive strain upon the motive power, shortening its life and reducing its ultimate earning capacity. Again, so insistent is the demand for satisfactory balances, periodically struck, that high corporate officers find it necessary arbitrarily to reduce working forces regardless of actual conditions. Vehement and imploring telegrams go from New York to outlying districts demanding reduction of expenses. The local official disbands some of his working forces, lets assembled material lie idle, knowing all the time that the ultimate cost will be greater because of the loss of efficiency in reorganizing his forces and resuming the work.

Apart from the economic loss involved is the sociological unrest engendered by treating men as pawns on a financial checker-board. The offsetting argument of the modern banker is that even though it cost more money later on, it is better to wait until money is more plentiful. The observing citizen is quick to detect the fallacy of this reasoning and quicker to condemn a financial system that demands such departure from real efficiency. A refreshing exception to this general practice is shown by the Chicago & Northwestern Railway which, under the old-fashioned administration of Marvin Hughitt, has actually insisted upon increasing its equipment in dull times because labor and material are then cheaper.

Men are the product of their environment, and the coming captain of industry is the man whose conception of trusteeship will be that of a scientific buffer between the financial power on the one hand and the practical necessity of the property and its employees on the other. The labor unions have been quick to see the weakness and blindness of capital. The tyrannical hold of labor today is due more to unscientific methods of capital, to absent treatment by large interests from New York, than to the cupidity of labor itself. A concrete case is that unscientific unit of performance, the train mile, which leads to many unsound conclusions and expensive outlays in railway operation. So dependable is human nature, so sound is public opinion in the long run, so honest and so able is the corporation officer of today, that the solution of these great questions will come through scientific study of the fundamental principles involved. Evolution will thus preclude the necessity for and prevent revolution.

It sometimes happens that human nature must be hurried to its conclusions. The greatest present need is an antidote for the unwillingness of men to profit by the previous experience of others. It would be amusing, were it not so expensive, to watch the gropings of many corporate officers for methods to test efficiency. Ignorant of fundamental principles, intolerant of outside suggestion, unable to detect the analogy in other undertakings, they repeat the expensive experiments of the past. Nearly every large corporation today is endeavoring to inaugurate some effective system of inspection or review. Nearly every one is falling short, because an attempt is made to have the cheap man check the work of the high-priced man. Nearly every one is disappointing its promoters, because of failure to differentiate between accounting, an operating or line function, and auditing, an inspection or staff function.

It often happens that what unfolds itself as a discovery to one is but a matter of principle long previously enunciated by someone else. Among the ideas that are contemporaneously revealing themselves to searchers after truth is the principle that most modern undertakings are too large to be concentrated in one man, however able or zealous, because it is absolutely essential that authority shall converge in some one individual. The false idea has gained sway that such a man alone could act in numerous cases. The application of this idea necessitates minimizing the cases in which the head must himself act. By a process of evolution, the chief-of-staff idea has unfolded itself to relieve such head and, at the same time, provide comprehensive action for a greater number of cases.

Another concept that has forced

its attention is that effective means must be provided for a comprehensive review of performance. The railway president cannot be left indefinitely to report upon his own performance. Granted this necessity, a fallacious attempt has been made to check the president through inanimate accounts, through reports prescribed by the Interstate Commerce Commission or other public bodies. It is now dawning upon those who are concerned how inadequate is such a test. A more satisfactory remedy is the outside expert, the disinterested reviewer, who is qualified by training and experience to report upon men and things as well as upon papers and accounts; a man who can draw his conclusions from first-hand information on the ground rather than from second-hand data in the office.

Perhaps the greatest revelation of modern organization is the consciousness, tardy though its arrival, that there is a distinct limitation to the size of undertakings, that volume may be the determining condition. The operating activities of many corporations have outgrown a detailed direction from a central source. The self-suggesting remedy is a decentralization of detailed activity and a re-

tention of centralized control. In many cases such efforts at decentralization are still very crude. It is hard to teach old dogs new tricks. Here again time and intelligent effort will supply the adjustment which the conditions demand.

Modern organization reveals to the student a far more pleasing picture than that beheld by the prophet of old. The religion of Fear, with its bottomless pit and lake of brimstone, has been replaced by a religion of Love with its heights of hope and its valleys of peace. Modern requirements have brought men together in large masses. They have organized together for one purpose or another. Political and economic efficiency have long been their cherished desires. As weaknesses developed in this organization they have sought improvement. Sometimes the attempt was wise, sometimes foolish, often ineffectual, but nearly always sincere. Whenever the effort ran counter to the general welfare or to the normal advancement of mankind, the organization quickly showed the defect. Out of it all, as modern organization sweeps into the newer day of composite efficiency, comes the delightful realization that its beacon light is scientific and enlightened altruism.

The End.





AMERICAN IRON-ORE RESERVES

THE Stanley Committee of the House of Representatives has spent over a year in a searching investigation of the American steel industry in general, and of the United States Steel Corporation in particular. The final report of the Chairman of that committee will be given to the public almost concurrently with this issue of THE ENGINEERING MAGAZINE; and it is to be expected that the conclusions reached by Mr. Stanley, and the recommendations which he makes, will receive the careful attention not only of lawyers and politicians, but of all those interested in any way in American industrial development. It will be recalled in this connection that the detailed reports of the Bureau of Corporations on the steel industry called attention to the fact that, in the final analysis, control of raw-material supplies was the only feature which might require further legislative consideration.

It will be of interest to our readers to compare the conclusions reached by the Chairman of the Stanley Committee and the Commissioner of Corporations with those presented in the next three numbers of THE ENGINEERING MAGAZINE by the leading technical authority on the subject. Our August, September and October issues will contain a series of three articles, by Mr. Edwin C. Eckel, dealing with various phases of the iron-ore reserve problem, in both its industrial and political relations. The series as now planned will include:—

1. The Element of Monopoly. (August issue.)
2. Actual Extent of American Reserves. (September issue.)
3. Valuation of Ore Reserves. (October issue.)

It will be found, we think, that this discussion marks a distinctly new stage in the evolution of opinion regarding ore-reserve ownership. Beginning with a summary of existing conditions as to ownership and control, the industrial and financial factors which influence the question are for the first time definitely determined, clearly stated, and followed through to their logical conclusions. Some of the matters here discussed will come before the courts for decision under existing law, while all of them may become factors in the formulation of a proper public policy in dealing with one of our greatest industries. It is possible that the final decisions, both by courts and legislatures, may follow more nearly the lines laid down by the engineer than the more radical suggestions of the official investigators.

COMING AND PARTING GUESTS

BY extreme pressure of professional work, Mr. Emerson has been prevented from completing the second article in his current series in time for this issue. The patience of our readers must be exercised in waiting another month for the beginning of the specific discussion up to which his June chapter led.

The pause in our welcome to Mr. Emerson's concrete presentation of efficiency in railway operation permits us to dwell in thought more lingeringly over our parting salutations to Major Hine, whose most interesting presentation of another philosophy of management makes its valedictory this month.

Reissue of the series in book form will be made as soon as the author's revisions can be obtained and the processes of manufacture carried out.

REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA

THE UNITED STATES PATENT SYSTEM

THE GOOD FEATURES AND UNCERTAIN ENFORCEMENT OF EXISTING LEGISLATION

*Dr. L. H. Baekeland** — *Metallurgical and Chemical Engineering*

IN the two preceding issues of THE ENGINEERING MAGAZINE, Mr. Gilbert H. Montague has ably discussed the recent decision of the Supreme Court in upholding the right of patentees to dictate under what conditions a patented article shall be sold or licensed, and some of the proposed amendments now under consideration for the modification of the existing patent laws. In Dr. Baekeland's paper, a review of which is presented here, is outlined the model features of our patent laws; the laborious, uncertain enforcement of patent rights, and some simple expedients toward effective reform.

Dr. Baekeland considers that the recent decision simply means that the owner of a patent is subject to the same privileges as the owner of real-estate, in the matter of what restrictions he may choose to include in the sale of his property. The sale of such patented article or such real-estate depends entirely upon whether the purchaser is willing to submit to the terms accompanying the sale: with this distinction, however, that the owner of real-estate or other private property enjoys undisturbed and perpetual ownership, whereas the patentee loses all rights to his patents and restrictions after the comparatively short period of 17 years has elapsed from the date of patent.

But the patent laws as framed under the Constitution of the United States, are primarily conceived for the benefit of the nation. No country has benefited more by its patent system than the United States. Compare the tremendous industrial development of such nations which have liberal patent laws, like the United States, Germany, and England, with that of the Latin countries, where patent laws are less favorable to the inventor.

There is one civilized country, Holland, which up till recently had no patent law whatever and allowed the unrestricted use of any invention. This ought to have been the Paradise of Infringers; it was easy enough to use freely in Holland processes patented in other countries, and to distribute from there infringing goods to all countries of the world. Yet what was the result? Holland, with her highly developed commerce, her abundant money supply, with a race of intelligent and enterprising men, remained industrially undeveloped, and still ranks as one of the least among the industrial countries of the world. Why? Because there was no incentive to saddle oneself with all the risks and outlays of starting a new enterprise or of improving methods of manufacture, knowing beforehand, that in case of success, one's

* President of the American Institute of Chemical Engineers.

neighbor could simply do the same thing without any restriction whatsoever.

This standpoint that good patent legislation is for the benefit of the whole nation, is too often lost sight of and it behooves every good citizen of this country to help improve the patent laws and the administration thereof. A patent is simply a contract between the nation and an individual, the inventor. By that contract, the inventor, in disclosing his secrets, confers a benefit on the nation, and the nation, in return, gives him for a rather short number of years, the sole use of his invention—followed immediately afterwards by absolute confiscation in favor of the public. The period of this limited monopoly is none too long if we take into consideration the time it takes to develop an invention into commercial shape; in many cases, inventions reach the money-earning stage only after the patents on which they are based have expired. In the meantime the disclosures made by the inventor stimulate enterprise and further invention, and induce the ideal form of competition—competition by improvement.

To this extent, therefore, the patent laws leave nothing to be desired, and work toward the general good of the public. While not perfect, they are generally considered as models of good patent legislation; to such an extent, in fact, that in all foreign countries, including Germany, any modifications in existing systems have tended toward the United States system.

The trouble in the United States has not been with the patent system, but in the enforcing of the contract between the nation and the inventor; that is, the protection of the patentee against infringers. The poor inventor, trying to enforce his rights

against the expert legal counsel of a wealthy corporation, must inevitably succumb to the prohibitory costs of carrying his case through court after court for an indefinite period of years, and so lose his case by default.

Formerly, all patent cases, on appeal, went by right, from the lower courts to the Supreme Court of the United States. The latter court not only rendered final decisions, but, what is more important, saw to it that the proper rules of practice and procedure were observed in the lower courts. The Supreme Court acted practically as a supervising body on our patent system, and lent considerable prestige to it. But through the rapidly increasing development of this country, the cases before the Supreme Court became so numerous that finally it took three to four years, after an appeal was filed, before a case could be heard. This amounted practically to a denial of justice, because some of the patents expired before their case was reached.

So in 1891, a remedy was inflicted, which has proved to be much worse than the ailment. Nine Circuit Courts of Appeal were organized, and each court, independently, can give *final* decision in patent cases. This has brought us into an intolerable condition of affairs. Indeed, each Circuit Court of Appeals can adjudicate only for its own circuit, and being independent of control of any other Circuit Court of Appeals, each court makes decisions as it thinks right, based upon the evidence submitted to this special court, and in accordance with its own view of the law. So *that we have now this absurd condition that some patents are valid in some parts of the country and invalid in others.* Any litigant with much money, who has been beaten in one circuit, can carry on his infringements with impunity in an adjacent

circuit or drag on new suits forever and a day. While doing so, he knows very well that he can postpone a final decision as long as he is willing to pay his lawyers. But this is not the worst of the situation. Since the Supreme Court of the United States is no longer *by right* the final arbitrator in case of appeal, our whole patent system has lost the prestige and corrective influence of a final court supervising the faithful observance of proper rules of practice and procedure.

A bill for a Court of Patent Appeals has been pending now before Congress from year to year, and seems to meet almost with unanimous approval, even from lawyers. The only serious opposition seems to be on the part of some politicians, who do not like the idea of new judgeships being created, while their political opponents are in power.

A very desirable reform in the practice of the patent office, would be the introduction of the German system of public objection to an "allowed" patent, before it is definitely "issued." In Germany, in Austria and in England after a patent has been examined and allowed by the examiner, the title and the claims are published and the copies of the text can be obtained from the patent office. Then during a period of two or three months, objections to the issue of the patent can be filed in writing, by anybody. Copy of the filed objections are forwarded to the applicant, who then has a few months to file an answer. In this way, the examiner has the benefit of a thorough public discussion of the subject before that patent is definitely issued. This involves a delay of several months in the issue of a valid patent, but this is a very small hardship, indeed, if one takes in consideration the fact that a patent issued after

severe public contestation gains much in value by its record. Furthermore, this way of proceeding is now successfully used in the U. S. Patent Office for the registration of trademarks.

Our interference rules may appear very logical in accordance with the conception that in the United States, a patent belongs to the first diligent inventor, independently whether he be the first patent applicant or not, as long as his invention has not been in commercial use before that period. To the uninitiated, this may seem an excellent safeguard to insure that the first inventor should receive the reward of his intellectual work. Unfortunately, any poor inventor, who has been through interference cases, knows that without much money an interference case becomes almost a hopeless proposition if he has to deal with wealthy antagonists. Even after the interference case is decided in one's favor, one has to take all the ordinary chances of further expensive infringement suits. Such a thing is impossible with the German system, where the first applicant, unless his application is based on fraud or theft, gets the patent, as long as no one else can prove prior use or prior public disclosure. Rigid examination, followed, after allowance, by a short period for public objection, makes the German proceedings relatively inexpensive, and gives added value and prestige to patents issued under this system.

For deciding priority in purely scientific publications it has been accepted that, "priority of publication, unless in case of fraud, means priority of conception." This simple rule, if applied to the Patent Office system, would sweep away the most complicated and most expensive part of our Patent Office methods. At the same time it would stop an inter-

pretation of our patent law, which is decidedly dangerous and unfair to the unsuspecting public, and has no advantage to the inventor.

Such reforms or improvements as these are relatively simple and could readily be obtained. But the immediate danger, Dr. Baekeland thinks, is that some Congressmen or Senators, ignorant of the real situation, but anxious to "fight the trusts," will rush

bills through which may work untold harm to the existing beneficent aspects of the patent system. He suggests that the President appoint a commission of competent men, who, before endorsing reforms, should consult with representatives from the national scientific societies, as well as with manufacturers, business men, representatives of the patent office, and lawyers.

CONCRETE TUNNEL LININGS

APPLICATION IN PRESSURE TUNNELS ALONG THE CATSKILL AQUEDUCT

M. E. Zipser—Engineering News

TOPOGRAPHICAL conditions, along the hundred miles of aqueduct from the Ashokan Reservoir to New York City, made desirable the adoption of frequent grade and pressure tunnels, rather than long and circuitous open cut excavations, wherever the cost of the former might be less than the cost of the latter.

For these tunnel constructions two general cross-sectional types, have been used: Grade tunnels of the horseshoe section, usually 17 feet high by 13 feet 4 inches wide, and pressure tunnels with circular section varying from 16 feet 7 inches to 14 feet in diameter inside of lining.

Pressure tunnels have been driven in preference to steel pipe siphons across the wide, deep valleys along the line of the aqueduct, and, in order to carry safely the high, unbalanced internal pressures when in service, have been placed at such depth that there will be at least 150 feet of sound rock above their roofs.

In the typical section shown in Figure 1, the *A* line defines the minimum thickness of lining, but the specifications require that the lining must average everywhere to the *C*

line, which is generally 5 inches outside of the *A* line. The *B* line, 13 inches from the *A* line, is the line to which the contractor is paid for excavation and concrete masonry, regardless of the actual area of the excavation.

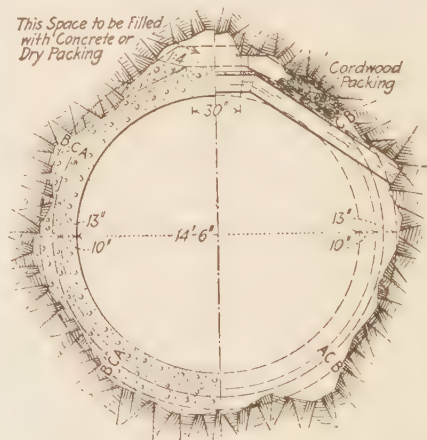


FIG. 1. TYPICAL SECTION OF PRESSURE TUNNEL

The Rondout pressure tunnel is 4.4 miles long and was excavated through eight shafts varying from 370 to 710 feet in depth. The end shafts are permanent shafts lined with concrete, and form part of the waterway. They are connected at the top with the aqueduct at hydrau-

lic gradient. Shaft 5, called the drainage shaft, is to be used for unwatering the siphon for purposes of cleaning, inspection or repairs. It is offset about 75 feet from the tunnel and connected with it by a drift in which is placed a bronze door closed and securely bolted when the tunnel is full of water. The five remaining shafts are construction shafts sunk solely for the purpose of expediting construction. They will all be closed and sealed with a concrete plug about 50 feet thick above the roof of the tunnel. The Wallkill pressure tunnel is also 4.4 miles long, reached through six shafts varying in depth from 350 to 480 feet, while the Moondna pressure tunnel is 4.8 miles long with seven shafts from 340 to 540 feet in depth. The Hudson River and Breakneck pressure tunnels are 3005 feet and 750 feet in length, respectively, the former being reached through two shafts 1187 and 1153 feet in depth, and the latter through one shaft 589 feet deep.

The concrete for tunnel lining is mixed approximately in the proportion of 1:2:4 for pressure tunnels and 1:3:5 for grade tunnels. The maximum size of stone specified is 2 inches. The proportions of the mix are varied from time to time as the requirements of the work demand and in accordance with the character and grading of the aggregates. As the cement is paid for separately, the engineer has absolute control over the proportions at all times, varying the mix and mode of application as he may see fit.

The lining for the pressure tun-

nels is being placed in three operations: first, the invert, which provides a firm support for the track and carriages used to move the side wall arch forms; second, the side walls, which carry the lining up to the horizontal diameter, and third, the arch, comprising the upper half of the section. These different steps are indicated in Figure 2.

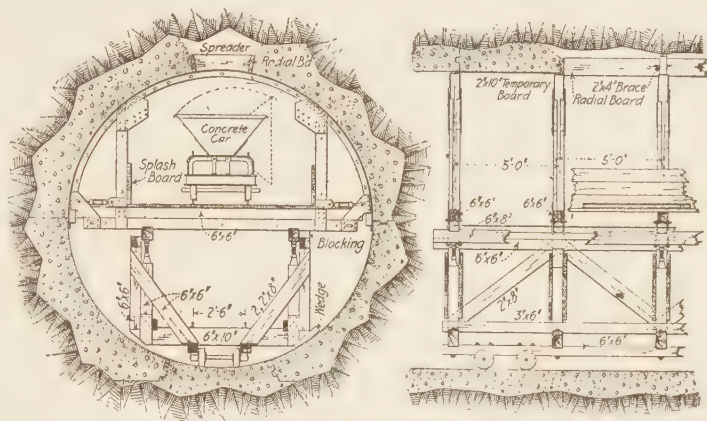


FIG. 2. ARCH FORMS AND CARRIAGE USED IN CONCRETE LINING

The invert strip is 5 feet wide across the top, with its sides radial. The forms for the invert consist of 2-inch side boards, with a 4x3-inch beveled strip bolted on the inside to form a key to engage the sidewall, as shown in the section. The forms are set accurately to line and grade and braced securely from the rock.

Shaping of the invert surface by the continuous method is done by means of a wooden template cut to 7 feet 1-inch radius in the 14 feet 6-inch diameter tunnels, resting on the top of the side forms and moved along longitudinally. The 7 feet 1-inch radius is used for the purpose of lowering the center of the invert strip slightly so that when the steel sidewall forms of 7 feet 3-inch radius are set in place, they will bear against the sides of the invert and tend to make a tight joint at the contact. At the end of each day's work a bulkhead is put in and a groove

formed at the end of the section. Shaping of the invert is done three or four hours after placing the concrete, and the surface is worked to a smooth finish by steel trowels.

After the invert strip is completed between two shafts and a track laid upon it, the next step is the placing of the concrete in the side walls and arch. The forms used for this purpose are of steel. Those shown in Figure 2, in use in the Wallkill tunnel, are of the same general design as those used in the other pressure tunnels, except that they are stiffer than the earlier designs, being provided with heavier plates and rigid, instead of loose-pin, connections.

The forms are collapsed by loosening the bolts connecting the ends of the horizontal channels with the gusset plates at the bottom of the ribs, which are then drawn inward by a pair of turn-buckles attached near the bottom of the vertical members shown in Figure 2. Owing to the circular shape of the tunnel section, these forms can be used both for the side walls and arch.

As originally designed, these forms were to be taken down piece by piece and bolted up again for the next filling. This operation proved cumbersome and uneconomical and a method was devised by the contractors on the Rondout tunnel, where the forms were first used, whereby the forms were collapsed and moved in units of 60-foot lengths or whatever lengths were used. Special carriages which run on the completed invert, and which handle the forms with great ease and rapidity, were also designed by the contractor.

Concrete is delivered to the working platform over an incline from 50 to 90 feet long, which is portable and so arranged that it may be taken down and moved forward on trucks in a unit with a minimum loss of

time. The concrete cars are drawn up the incline by a cable from a hoisting engine which in the Wallkill and Moodna tunnels has been placed on top of the working platform.

After the concrete cars are dumped on the platform, the concrete is shoveled by hand into place behind the forms, where it is agitated by men treading on it and spaded back from the face of the forms so as to produce a smooth dense finish along the waterway. The forms are thoroughly cleaned and greased with heavy oil before the concrete is placed. Temporary wooden bulkheads are used at the ends of the sections with a key to engage the next section. A groove is also formed along the top of the side wall to bond with the arch section.

When the concrete in the arch has reached the level of the top of the uppermost side plates, "radial" boards are generally placed longitudinally on either side in 5-foot lengths, as shown in Fig. 2 and the concrete which is of drier consistency is "banked up" on a slope above the boards as shown. The radial boards are braced transversely by temporary wooden spreaders. While the "banking" is being completed, work on the key is started at the end adjacent to the old arch section by setting in place between the ribs the first key plate either $2\frac{1}{2}$ or 5 feet long, and the concrete is then shoveled into the key above the plate, by end handling. When no more concrete can be placed in the key in the first panel, the radial boards in the adjacent panel are removed, another key plate is put in place and the keying proceeds in this manner, continuing in one direction and closing on a bulkhead at the free end of the form.

In order to fill all voids over the tunnel arch and back of the lining,

grout is forced under pressure through pipes which are set in the concrete in the arch and elsewhere at the time the lining is placed. An endeavor is made not only to fill the spaces between the concrete and the rock, and the voids in the dry packing where the latter has been used, but also to plug the crevices and water bearing seams with a view to making the tunnel "bottle tight." To prevent the formation of air pockets and insure a complete filling of the voids, vent pipes are placed at all the high places in the roof. Grouting of any stretch is not begun until at least three months has elapsed after placing the lining in that stretch.

The method of grouting which was adopted on one section of the work in the Rondout tunnel was substantially as follows: When placing the lining, grout pipes were set at low spots in the roof, generally about 75 to 100 feet apart with a vent pipe about 10 feet from each grout pipe, and vent pipes were also placed at the high points in the roof. Grouting was done in three stages. At first a grout cutoff wall was formed at each of the above low spots by forcing grout through the low pipe

until the grout flowed from the adjacent vent pipe whose upper end was at a higher elevation. This grouting was done under a low pressure, usually from 30 to 40 pounds. After the grout cutoff walls had been formed for a stretch of tunnel, the second stage consisted in grouting the sections between the cutoff walls, starting with a pressure of 100 pounds and raising it to 300 pounds per square inch. When no more grout could be forced in under this pressure the high vent pipes were opened and any water that had accumulated was allowed to run off. After a stretch of tunnel was grouted in this manner, all the valves were opened, the plugs at the ends of pipes were removed, and any hole that was open or that showed a flow of water was connected up and grouted under a pressure of 275 to 300 pounds.

The grout used in the Rondout tunnel was mixed in batches consisting of one bag of portland cement weighing 95 pounds, one bag of fine sand weighing 75 pounds and 0.82 cubic feet of water, except for high-pressure grouting, where neat cement and a higher percentage of water were used.

EMPLOYERS' LIABILITY

A RESUME OF THE WORKMEN'S COMPENSATION ACTS IN THE SEVERAL STATES

Miles M. Dawson—Machinery

ELSEWHERE in this issue will be found a paper by Mr. Mancius Smedes Hutton, comparing the workmen's compensation acts in Europe and America; in connection therewith the following abstract, reprinted from *Machinery*, of an address delivered by Mr. Miles M. Dawson before the National Metal Trades Asso-

ciation will be of interest, in that it shows the extent of legislation enacted by the several States of the United States toward holding employers liable for industrial accidents and the amount of compensation accorded.

Under the common law and employers' liability statutes, an employer is held accountable for accident only in case he himself or his

direct agent is negligent; and not even then providing the employe is contributorily negligent, or the injury has been caused through the carelessness or negligence of a fellow workman, or that the employe understood and assumed the element of danger which the nature of the work demanded. These three defenses are known respectively as the "contributory negligence," the "fellow-servant" and the "assumption of risk" rules.

The purpose in workmen's compensation acts is to cause the employe, or his dependents in event of his death, to receive compensation on a reasonable basis, without regard to fault.

In New York the option was given to employers to whom the compensation act did not directly apply, to avail themselves of its provisions by agreement with employes. There was no special inducement to do this, however, and the rates of premium to cover the risk under the compensation act were so much higher than rates charged by the same companies to cover the risk under the common law and the employers' liability act, that virtually no employers took advantage of the privilege.

California, Illinois, Kansas, New Hampshire, and Wisconsin have passed compensation acts of the usual type; that is, providing for payments of a definite percentage of the wages (usually with a minimum and a maximum for a certain number of weeks, and a definite amount based upon the weeks in event of death) for all accidents occurring while at work, without regard to fault. Under these laws it was made optional with the employer either to come under the act or not to do so; but in case he did not do so, two of the usual defenses, the "fellow-servant" rule and the "assumption of the risk" rule were

abrogated, and in most cases the "contributory negligence" applied only to reducing the damages. In Illinois and Kansas, if the employes refuse to be under the compensation act, these defenses are available against him and his dependents.

The law in New Jersey provides for the compensation of all accidents occurring while at work without regard to fault, and applies to all employers unless by written notice to a given state officer they elect to remain under the common law and the employers' liability act. If they do so elect, the "fellow servant" and "assumption of the risk" rules are abrogated, "the contributory negligence" rule can only be used to reduce the verdict, and the burden of proving "contributory negligence" is put upon the employer instead of, as previously, the burden resting upon the employe to prove that he was not contributorily negligent.

In three states, Massachusetts, Ohio, and Michigan, laws have been passed offering to employers the election to insure their employes so as to provide compensation to them and their dependents for the consequences of all accidents occurring while at work, without regard to fault. In these states, also, in case the employer does not so elect, the defenses of the "fellow-servant" and "assumption of the risk" rules have been taken away, and also the defense of "contributory negligence," except that in Ohio and Michigan it may be used to reduce the amount of the verdict.

In other respects, the laws in regard to insurance in these three states differ very considerably. Thus in Ohio the insurance must be in a state insurance fund, charging premiums fixed by a board, with the privilege of assessing for more; and, of course, with the privilege of taking into account previous payments

in fixing payments for future years. In Massachusetts, the insurance may either be in a mutual association of employers under state supervision or in any licensed mutual or stock insurance company. In Michigan the insurance may be in a state fund, in a licensed or stock insurance company, or by the employer himself satisfying the state board that by reason of his resources and the number of his employees, it will be safe to permit him to be the insurer.

There is a good deal of complaint in California that the rates under the workmen's compensation act are materially higher than under the common law and employers' liability act, even with the defenses abrogated; and consequently many employers have not elected to come under the former. This complaint is also made in other states, notably Wisconsin, where, however, mutual companies are being organized under the encouragement of state authorities; and Ohio, where the stock insurance companies are making as strong a fight as possible to keep the business from going to the state insurance fund. The Michigan and Massachusetts acts have not yet taken effect.

In the state of Washington a compulsory insurance act took effect on October 1, 1911, requiring all employers to whom the act applies to insure with the state insurance fund. For the purpose of the fund they are divided into a good many classes, each of which must pay its own claims. The total premiums collected amount to about \$500,000, the payments and reserves for sums payable hereafter on account of claims already arising amount to about 30 per cent, and expenses to about 15 per cent. The Washington law differs from the other laws in one other respect, *viz.*, that the amount payable in event of disability, from \$20 to

\$35 per month during disability, and to the widow for herself and children, from \$20 to \$35 per month, varies not according to the wages, but according to the number of dependents.

An act in effect in Montana providing for certain rates of compensation to be paid to miners through the medium of compulsory insurance in a state fund, each employe, however, or the dependents of an employe killed by accident, having a right to elect, after the accident occurred, whether to accept this compensation or proceed under the common law or employers' liability law.

In the state of Nevada, notwithstanding the decision of the Court of Appeals of New York, an act was passed, requiring, subject to reduction of amount in event of "contributory negligence," all accidents occurring while at work which are not compensated under the common law or employers' liability law, to be compensated to the amount during disability of 60 per cent of the wages for a time until a maximum amount of \$3,000 is paid, and in event of death, a minimum of \$2,000 and a maximum of \$3,000.

During the past year, the question of the constitutionality of some of these acts has been before the courts and decisions have been rendered as follows: In Massachusetts, the matter was submitted by the legislature before the act was passed, to the Supreme Judicial Court and the proposed act was held to be constitutional. In Ohio the elective insurance act has been before the Supreme Court and has been held to be constitutional. In Washington, the compulsory state insurance act has been before the Supreme Court and has been held constitutional. In Wisconsin, the elective workmen's compensation act has been passed upon by the Supreme Court, and has also been held to be

constitutional. In New Jersey, the lower court has passed upon the law and found it to be constitutional.

The benefits provided under these various acts vary as follows: Temporary disability, from 50 per cent of the weekly earnings, with a \$4 per week minimum, and \$10 per week maximum in Massachusetts, to 66 2/3 per cent of the weekly wages in Ohio, with a \$5 minimum and \$12 maximum. Six of the states fixed the percentage at 50 per cent, one at 60 per cent, two at 65 per cent and one at 66 2/3 per cent. The term of payment varies from 300 weeks in New Hampshire and New Jersey to the entire period of disability in Illinois (where the amount payable after eight years, however, is reduced), Ohio and Washington. The maxi-

mum amounts of total disability compensation when named in the laws, range in the neighborhood of \$3,000 except where compensation is payable throughout the disability, when no such limit applies.

In the following states commissions have been appointed and are now at work upon bills to be introduced in the next legislatures, *viz.*: Pennsylvania, Colorado, North Dakota, Missouri, Iowa, West Virginia, Nebraska, Connecticut, Rhode Island and Delaware. It is said that the Missouri commission has abandoned the task, no appropriation having been made. In Texas the governor was asked to appoint a commission to report to the legislature at its then session, but no appointment was made.

AGGLOMERATION OF FINE MATERIAL

CLASSIFICATION OF PROCESSES AND PHYSICAL PROPERTIES OF BRIQUETTES

Walter S. Landis—American Society of Mining Engineers

WITH the increasing prices of fuel and ores and the greater demand for economy in the operation of industrial plants, more attention has been paid in recent years to the utilization of waste products and low-grade ores and fuels. Much of the waste has been occasioned by the inability to utilize finely-divided ores and fuels in the furnaces because they could not be kept there, or else because they clogged up the furnace-shaft so that gases could not be forced through under ordinary conditions of operation. As a result, all such fines were thrown on the dump. Again, with the exhaustion of the richer deposits of ores, concentration of lower-grade ores becomes a necessity, and most concentrates are produced in a finely-divided condition. Aside from

these considerations, there is also the economy in the cost of operating the plant; a furnace running on agglomerated material will have a much greater output than one working on fines. In one instance the charge of an iron blast-furnace was changed from fine concentrates to briquettes and the output was increased four-fold; better results could have been obtained had facilities been at hand for taking care of the increased output.

A partial list of materials that have been agglomerated by one or another process includes, the slack obtained in the mining, preparation and storage of fuels; the concentrates obtained in fine-crushing ores for blast furnaces; the fine ores, especially of iron; the flue-dust, sweepings, etc., from blast-furnace plants,

and scrap-metal, such as filings, chips, etc.

In general, the agglomeration processes may be divided into:

I. Those utilizing certain properties in the material for producing the desired coherence.

II. Those obtaining coherence through the addition of a foreign substance or binder.

Under Group I. are four classes:

1. Certain materials, when moistened with water and molded into form and dried, possess considerable coherence. Ores carrying soluble salts, clay, easily hydrated compounds, etc., are frequently found amenable to this simple treatment. A few iron-ores and roasted products are actually treated in this manner, but the product possesses the great disadvantage that on heating to a temperature sufficiently high to drive off the water the briquettes fall to pieces.

2. Pressure greatly assists in developing the cohering power of many materials; possibly all materials could be agglomerated under pressure alone if sufficient pressure could be applied, but the use of pressure alone is limited to very few cases.

3. All materials on being heated to a high enough temperature pass through a pasty or semi-fused state and cohere to such an extent that on cooling a more or less firm mass results. This phenomenon is called sintering. If done in a rotating furnace or rotary kiln the sticky masses roll together like snowballs, and small round particles are formed, which are called "nodules"; the process is called "nodulizing".

This sintering property of a material may be taken advantage of by molding the material into briquettes, using only a slight pressure to insure filling the mold, then burning the briquette so formed at a temper-

ature that will insure cohesion. This is the principle of the well-known Gröndal process.

4. This class is represented by processes employing a combination of pressure and sintering. It is difficult to fix exactly the limits which differentiate a process truly belonging to this fourth class from one of the third, since the difference is wholly in the degree of pressure employed. In this fourth class are included all processes which use pressures exceeding 30 atmospheres for the formation of the briquette.

Under Group II. are included the greatest developments of the briquetting processes. The use of a binder much simplifies the whole operation, as the binder acts as a cementing medium to hold the inert particles of material together. It is almost impossible to list all the binders that have been used; a few of them are, clay, lime, ground slags, natural and Portland cements, water-glass, kieselguhr, carnallite, tar, pitch, asphalt, petroleum, sulphite residues, naphthaline, paraffine, molasses, resin, starch. Most of these act of themselves if the precaution is taken to insure a thorough mixing with the material to be briquetted. Others require that the briquettes be aged, or even heated after formation to temperatures up even to redness.

The operations of Group II. may therefore be divided into three subclasses: (a) Processes in which the binder is mixed with fines and molded under low pressures; (b) processes in which higher pressures are used along with the binder; (c) processes in which a binder, and possibly pressure, are used, with a subsequent heat treatment. The first two are self-explanatory; the last may be subdivided into processes which use baking in superheated steam, or even agglomerating in a furnace.

The physical properties which a briquette should have may be summed up as follows:

It should be strong enough to stand handling without undue breakage. In a drop-test of about 6 feet not over 25 per cent of the number dropped should break, and none of the broken ones should pulverize into the original texture of the material before briquetting.

Where the agglomerated material is to be stored or transported before use, test briquettes should be subjected to the action of rain, snow, frost, and sunshine, since none of these agencies should affect a well-made product.

For proper reduction in the shaft-furnace the agglomerated material should be porous. A submergence test in water for 24 hours should show a porosity of 20 per cent of its volume. One of the greatest drawbacks to the nodulizing process is that the nodules are non-porous, and therefore difficult to reduce. The addition of lime to the charge of the nodulizing kiln somewhat counteracts this non-porosity, but unless

carefully made these nodules will not withstand some of the other recommended tests.

Disintegration should not follow the exposure to water-vapor at 150 degrees Centigrade, because the top of a blast-furnace contains vapor at this temperature. The test for disintegration is best performed by submitting the briquette to a steam-pressure of 60 pounds per square inch for several hours. Care must be taken to submit briquettes containing certain binders to this test, since some of them will fall to pieces under the action of hot water-vapors in the furnace.

Briquettes should not disintegrate when heated to redness. This test can best be done in a muffle, and if conditions permit should be in an atmosphere of carbon monoxide and dioxide. Many of the hydrated briquettes will not stand this test.

No briquette should contain a binder that exerts a harmful influence on the product of the furnace. No sulphur compound, for instance, should be introduced into any such briquette.

CONTROL OF ELECTRIC MINE HOISTS

THE LEONARD SYSTEM OF CONTROL BY VOLTAGE VARIATION

S. Haar—General Electric Review

AN examination of the various methods proposed for the control of hoist motors establishes the existence of two broad classes, rheostatic and varying voltage control, the former being simpler and the latter more precise. The action of the hoist motor during the period of acceleration being the same with either method.

Any motor can be governed with rheostatic control, as, in its simplest form, it merely reduces the starting

current and reverses the direction of rotation of the motor; dynamic braking is possible as a result of more complication. Small hoists, more especially sinking and contractors' hoists, if equipped with direct current motors, usually have series wound motors. After the acceleration, the speed is entirely beyond the operators' control and is likely to vary considerably. In order to stop the hoist, the usual practice is to open the line circuit and allow the

In voltage control, called Leonard control after its inventor, H. Ward Leonard, there is much greater scope for improving the operation of the hoist motor. As is well known, the hoist motor is a shunt wound separately excited direct current motor; power is supplied to it by a generator of variable voltage and reversible polarity, each motor having its own generator. The fact that practically independent of the load the speed of the motor corresponds in magnitude and sense to the voltage of the generator, renders possible a

The diagram illustrates the electrical system of a model locomotive. At the top, the 'Power Circuit' is connected to a 'Disconnecting Switches' block. This block contains a 'Closed When Switch is Open' switch, an 'Oil Switch', and a 'Relay'. The circuit then splits into two main paths. The left path goes through a 'Potential Transformer' and an 'Exciter Switch' to a 'Rheostat' and a 'DC Exciter'. The right path goes through a 'Voltmeter on Switchboard', an 'Ammeter on Analog', and a 'Circuit Breaker' to a 'DC Motor' and a 'Switch'. Both paths converge at a 'Controller' which manages the 'Generator Field Resistance' and 'Motor Field Resistance'. A 'Weight Adjusted Rheostat to Reduce Generator Voltage in Case of Over Travel' is also shown. The system includes several meters: 'Ammeter', 'Voltmeter on Switchboard', 'Ammeter on Analog', and 'Voltmeter on Pedestal'. Safety features include 'Interlocked Switches' and a 'Dead Weight' mechanism. The diagram is labeled with various components and their interconnections, providing a comprehensive view of the locomotive's power system.

ther it is unnecessary to interrupt the heavy current in the armature circuit for reversal of the hoisting drum.

In the accompanying diagram the armature of the hoist motor is connected directly to the generator, and the fields of both hoist motor and generator through the controller to the exciter. In the armature circuit there are the overload circuit-breaker and disconnecting switch, ammeter with zero point at the middle of the scale, and a contactor which opens at the "off" position of the controller. The circuit-breaker is set for extreme overload so that it will open the circuit only in case of dam-

age to the machine, as breaking the armature circuit robs the operator of his control over the motor. For this reason the breaker is provided with an auxiliary switch which closes the circuit of a relay, which in turn short-circuits the brake magnet and sets the emergency brake, causing prompt stoppage of the motor. In certain European equipments the unwillingness to open the circuit results in using the circuit-breaker merely as a switch for short-circuiting a high-resistance, the purpose of which is to reduce an excessive current. It is questionable if such an arrangement is as valuable as the arrangement shown in the diagram. It is necessary to have an ammeter with the zero in the middle of the scale, because the hoist motor is reversed by reversing the polarity of the generator voltage alone; this causes the motor current for successive trips to be opposite in direction. Furthermore, whenever the motor is reduced in speed by dynamic braking, the current reverses. With the line switch and the circuit-breaker; both sides of the circuit can be opened in case any work or cleaning around the motor is to be done. The contactor prevents the motor from creeping during the loading period on the residual voltage of the generator.

A moderate amount of speed adjustment by field control is useful if the voltage of the generator varies considerably, such as occurs when a flywheel motor-generator set is employed. No increase over the normal speed is sought, but the field of the motor is weakened just enough to maintain the speed with the decreased voltage. The resistance points for field control has been strengthened to its full value, after which the armature current usually falls off so that the commutation of

the motor is not affected by the weakening of its field. The same average speed might be attained by over-exciting the generator for a higher voltage; but this would result in exceeding the legal limit of speed, and reducing the efficiency of hoisting by increasing the generator losses.

The field circuit of the motor includes, also, the brake magnet coil, so that any accident to the former automatically sets the emergency brake. This is an important provision, as the failure of the motor field nullifies the arrangements for speed control. It will be noted that the brake is also set if the skip passes a predetermined distance beyond the regular landing places, if the motor circuit-breaker opens, or if the main oil-switch is tripped. The circuit-breaker will not open unless a dangerous current exists, and it is advisable in such a case to stop the hoist as quickly as is safe. The opening of the main oil-switch during retardation, or other form of regenerative braking, instantly terminates the braking effect and renders probable a rise in speed, so that it is necessary to interlock the oil-switch and the emergency brake.

A possible safeguard which may be connected with the action of the limit switch is an automatic rheostat in the circuit of the generator field so arranged either with a weight or a motor that the closing of the limit switch sets the apparatus in motion, thus gradually reducing the generator voltage by inserting resistance into the field circuit. If the brake holds, this rheostat is unnecessary, and the stoppage of the motor will result probably in the opening of the circuit-breaker; while if the brake does not hold, the damage will be done before the voltage is reduced to zero by the rheostat. Failure of the

line voltage, or trouble in the motor-generator set, sufficient to cause abnormal current, will both open the main oil-switch and put into action the other safety-devices. An over-speed trip might also be included; but with a synchronous motor driving the generator the effect of any dangerous speed would be a current large enough to trip the oil-switch. Such a device should properly be included with an induction motor set having an automatic speed regulator.

Comparing rheostatic with Leonard control, the principal advantages of the latter are the elimination of rheostat losses, the recovery of stored energy by regenerative braking, and the far superior speed control. This latter is most emphasized at partial speeds, the steadiness of any speed with varying load being conceded to be unapproachable by

the other system. In regard to the question of efficiency, it may be said that busy main-shaft hoists operating under favorable conditions, will consume only about 85 per cent. of the energy required with rheostatic control in spite of the losses in the auxiliary machines. This statement has been framed to eliminate the case of the hoist operated infrequently, where the light-load losses of the motor-generator set for many hours would make its use prohibitive. The simple and effective speed control of the Leonard system has fostered the development of safety devices, so that the reliability of this form of equipment is unattainable by other kinds of apparatus—a fact which has been recognized by certain government boards as evidenced by their permitting higher speeds in hoisting men.

SAFETY IN MACHINE SHOPS

STANDARDIZATION IN SAFETY DEVICES FOR THE PROTECTION OF WORKMEN

David S. Beyer—American Machinist*

MACHINE-TOOL builders, as a class, have been progressive in the matter of adoption of safety devices and were among the first to recognize their importance. There is probably no other line of machinery that is as generally well-protected as the machine tools which may be bought in the open market today. There is still a tendency, however, on the part of some manufacturers to lag behind the average and to submit to the more stringent safety requirements that are now being called for, only when compelled to do so.

One of the reasons why this is so, and undoubtedly the chief one, is the absence of any well-defined standard,

to be met by tool builders, on a competitive basis. The legislation bearing on this subject in the different states varies considerably, and the interpretation of this legislation varies even more. Much confusion would, therefore, result if a manufacturer having a wide range of territory, endeavored to study out every local requirement, and arrange his equipment in accordance therewith. Even in an individual state the laws are usually of such a general nature, and so vaguely defined, that there is opportunity for an endless argument if one is inclined to quibble and hold out for fine distinctions.

On the other hand, the owner or operator may be running his machin-

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ery believing that it is properly guarded, but when an accident occurs and he is sued for damages, the prosecuting attorney naturally takes advantage of the condition and insists that the fact that an accident did occur is the best possible proof that the machine was not properly guarded. This results in penalizing a man for a condition which is not legally defined with sufficient clearness to enable him to determine beforehand whether he is within the scope of the law or not.

So long as such vagueness exists, machinery manufacturers will hesitate to make the necessary changes in their designs to bring about ideal conditions. There is a real inducement for not doing so, since the average purchaser is apt to pay the lowest price for a machine which will do his work, and is likely to overlook the fact that the absence of safeguards may be a factor in its low cost.

Realizing the need of such standardization to govern the construction of manufacturing equipment purchased from outside builders, the subsidiary companies of the United States Steel Corporation have prepared specifications defining their safety requirements for various classes of equipment; those for machine and carpenter shop tools read as follows:

General—All gearing shall be completely inclosed with substantial cast-iron or sheet-steel covers, so designed as to be readily detachable; all couplings, set-screws, keys, bolts, etc., in moving parts, must be countersunk or covered in such a way as to eliminate danger of accident; unused portion of keyways to be filled so as to present a smooth surface.

In addition to the above general specifications, the following provisions must be made for the various machines designated:

Planers—Planer beds shall be substantially covered with cast-iron or steel plate—the latter, if used, to be not less than 3/16 in. in thickness.

Drills—Wherever possible, counterweights should be placed inside the ver-

tical column of drill presses. Where this cannot be done, some auxiliary means must be provided for retaining the weight in case the supporting chain or rope breaks, this weight being suspended in such a location as to offer the least possibility of injury in case it should fall.

Grinding Machinery—Emery wheels must be provided with adequate safety hoods, having exhaust connections, these hoods to be of steel, not less than 3/16 in. in thickness. Flanges must be at least half the diameter of the new wheel, and have cushion washer between the wheel and flange. Roll grinders, tool grinders, etc., are to have the wheel covered as completely as the character of the work will allow.

Woodworking Machinery—Jointers or surfacers must be equipped with standard safety cylinders, and have exhaust connections for removing shavings. Daniels' planers should be provided with a guard which will prevent the knives from flying out. Band saws are to have both the upper and lower wheels protected with woven wire or other suitable inclosure across the face of the wheel, and a guard at the rim to prevent a breaking saw from springing outward. Swing saws are to be covered as completely as the character of the work will allow.

It will be noted that the first requirement is that all gearing shall be completely inclosed. Exposed gearing is the chief shortcoming that may be found in all classes of machine tools. With the progress that has already been made in that direction, however, it is really not a very serious matter to carry this on to its logical conclusion, which has only been reached when all the gears are entirely encased. A sweeping requirement of this sort does away with the necessity for an argument in each individual case and allows every manufacturer to know exactly what he is bidding on, and he also knows that his competitor must bid on the same thing before his bid will be considered or accepted.

A great many people seem to have the idea that if a set of gears is out of reach above a man's head, or if a setscrew is located in such a place that his work would not bring him in direct contact with it, there is no danger, or that the danger can be ignored.

Anyone who makes a study of accidents and the conditions that lead up to them, will soon be convinced that this is not the case. In one respect, just the reverse is true, in that a danger which is obvious and imminent will make more of an impression on the workman, and he will take care to avoid it; where the source of danger is remote and more or less out of the way, a man is likely to forget about it and be caught entirely off his guard. The following cases will illustrate the point.

A man had his hand crushed off in a pair of gears about eight or nine feet from the floor and which ordinarily would have been entirely out of his reach; he stepped up on the frame of a machine to feel a bearing which he thought was getting hot, and in so doing inadvertently thrust his hand into the gears.

In another case a pair of gears was located between two machines in such a position that the gears ordinarily would not be considered dangerous. They were covered over the top and ran out at the bottom, so that it would be impossible for anyone to be drawn through the mesh line and crushed. A girl operator at one of the machines dropped her glasses between them, and in reaching after the glasses brought her head in contact with the bottom of the gears, in which her hair became entangled, and her scalp was badly lacerated in consequence.

Another reason which is often given for omitting protection in some cases, is the slow speed at which the machine may be running, the idea being that where the movement is relatively slow, an operator would have time to escape in case he should be accidentally placed in a dangerous position. Within the past year three accidents occurred, two of them resulting in broken arms, and one in

the loss of a hand, in machinery running from 5 to 8 revolutions a minute. To a casual observer this speed seems so slow that the danger would appear to be infinitesimally small.

Such experiences make it apparent that the only positive way to avoid accidents of this kind is to entirely inclose the gearing, irrespective of its location and arrangement. It is not sufficient merely to put a band across the face of the gear, as that usually leaves the side of the teeth exposed at the mesh line, and very often the gear has spokes through which a man's arm might be thrust and broken or crushed against an adjacent part of the frame. By this clause is meant that both the sides and the face of gears shall be so inclosed as to keep them entirely out of sight.

Overhead shafting has contributed its good proportion of accidents, notwithstanding the fact that it is ordinarily out of reach. These accidents occur chiefly to men repairing belts or replacing them on pulleys, and to the oilers whose duty it is to look after the overhead bearings. The hazard to oilers can be largely reduced by the erection of suitable walks and platforms from which the shafting can be reached in safety. In some cases it is possible to use a long-spout oil can by which the bearings can be filled from the floor, in conjunction with suitable cups or pipes attached to the bearings.

Aside from the question of mechanical safeguards, there is that of caution and care on the part of the workmen, which is a very important factor in the reduction of accidents. The attitude of the shop foreman is very largely reflected in the actions of his men, and just as he can insist on neatness and order being maintained in the shop, so he can educate the men under him to be cautious and careful of their own safety.



THE STEAMSHIP 'FRANCE'

M. Gouriet—Le Genie Civil

THE fleet of the Compagnie General Transatlantique has been augmented recently by the addition to its lines of the largest vessel yet constructed in French shipyards. The *France*, built at the Saint-Nazaire yards, sailed the 20th of April on its first trip in the service of its company from Havre bound to New York. This vessel continues the line of ships, *Lorraine*, *Savoie* and *Provence*, built since 1898 at the same yards, and destined solely for the rapid transport of mail and passengers across the Atlantic.

Work was commenced on the *France* on the 20th of April, 1909; it was launched the 20th of September, 1910, at which time its displacement was about 11,300 tons—the heaviest launching weight yet occurring in French yards. The total time for its construction was exactly three years.

The leading dimensions of the *France* are as follows:

Length over all.....	217.23 m.
Length between perpendiculars.....	208.83 m.
Extreme breadth.....	23.00 m.
Depth to upper deck.....	24.00 m.
Maximum displacement.....	27,180 tons
Draught under load.....	9.10 m.
Cargo capacity.....	1,400 cu.m.
Bunker capacity.....	4,200 cu.m.
Number of decks.....	8
Number of transverse bulkheads.....	13
Number of lifeboats.....	22

The weight of passengers, provisions and cargo represent but 2.8 per cent of the total displacement of 27,180 tons. This fraction of displacement in liners is apparently decreasing; on the *Savoie*, which was placed in service in 1901, it was 7.5 per cent; on the *Provence*, which made its first trip in 1906, it was not more than 4.7 per cent. From such small items one can appreciate the great care exercised toward economy in avoidable weight.

The *France* will have a maximum list of 2,526 persons, divided as follows: 534 first-class passengers, 442 second-class, 950 third-class, and 600

officers and crew, including stewards, stewardesses, stokers, etc.

The hull-plates have a minimum thickness of 20 millimeters. In the bottom the plates and members are of soft steel with a resistance against rupture of 50 kilograms per square millimeter. In the upper plates high tensile steel was used having a resistance of 60 kilograms per square millimeter. A double bottom runs nearly throughout the length of the ship, and is divided by fifteen watertight compartments, comprising the water-ballast. This assures the stability of the ship proportionately to the coal consumption. This water-ballast has a total capacity of 1,967 cubic meters, representing about 2,018 tons of salt water when completely filled. There are also two water-ballasts for fresh water, with a total capacity of 725 cubic meters.

The ship on leaving port carried 800 tons of fresh water, of which 400 was for use in the engines and 400 for passengers and crew. This amount provides 20 liters of wash-water and 6 liters of drinking water per capita per day.

The ship is divided crosswise into fourteen compartments by thirteen watertight bulkheads. The bulkhead doors are operated on the Stone-Lloyd hydraulic system, as used in the earlier vessels, with the point of control on the bridge. The filling of any two transverse compartments would not affect the navigability of the ship.

There are four boiler rooms, each occupying a transverse compartment, placed one before the other, and having a total length of 77 meters. The boilers are of the cylindrical type with from four to eight furnaces; 11 double-ended boilers with 8 furnaces each, and 8 boilers with 4 furnaces each, or a total of 120 furnaces for the nineteen boilers.

Electricity necessary for light and power is supplied from two equal-powered stations, situated on the G deck. Each of these stations operates two 400-watt turbo-motors. The forward station operates the lighting and cabin ventilating systems, while the after station furnishes power for the furnace draft fans. These stations are interconnected, however, and either may perform the duties of the other.

The Linde duplex, ammonia refrigerating system is employed, operated by a Cail refrigerating engine.

The interior arrangements on the *France* differ materially from those on the other ships. For example, the lowest continuous deck, G, is traversed by a large passageway which communicates with the several transverse compartments, doing away with the necessity of descending to the hold and opening the bulkhead doors. In this large passageway are found the greater part of the necessary auxiliary supplies, not only for the boilers and furnaces, but also for the life and safety of the ship. The passageway also opens at the stern into various provision magazines, and quarters for stokers, stewards, etc., and at the bow into quarters for emigrants and crew.

The accommodations for first-class passengers occupy all the upper part of the ship and most of the lower decks. Quarters for the second-class passengers occupy the several decks at the stern of the ship, while the third-class is forward.

The first-class salons are most commodious and finished with all possible convenience. The cabins are all equipped with bath rooms, and the state-room suites contain every luxury.

Second-class cabins are but slightly inferior in their accommodations to the first-class cabins, and are much

more luxurious than first-class on the older boats.

In the trials of the *France* an average speed of 25 knots was maintained for twenty-four hours, which exceeded all expectations. With the exception of the *Mauretania* and *Lusi-*

tania of the Cunard line, the *France* is the fastest steamship in the world. At this speed the engines developed 47,000 horse-power, and yet the coal consumption was one-tenth less than the amount estimated previous to the trials.

THE FLORIDA EAST COAST RAILWAY

DETAILS IN THE CONSTRUCTION OF THE OVER-SEA ROUTE TO KEY WEST

Frank M. Patterson—Railway Age Gazette

THE inauguration of traffic over the entire extension of the Florida East Coast Railway to Key West on January 22nd of this year effected the realization of the plans long held by Mr. H. M. Flagler, the promoter of the road. With the purchase of a small railway extending from Jacksonville to St. Augustine, in 1885, Mr. Flagler became impressed with the opportunities for agricultural development in southern Florida, and eventually, by purchase and construction, extended his holdings until in 1896 the Florida East Coast Railway entered Miami, on Biscayne Bay, 366 miles south of Jacksonville.

The growing importance of trade with Cuba, after the Spanish war, and the certainty of the construction of the Panama canal led to the determination to extend the railway to some point where more satisfactory harbor facilities could be obtained. With this intent surveys were made through the Everglades to Cape Sable, the most southerly point on the mainland. After thorough investigation, however, this route was rejected, and it was decided in 1904 to build to Key West, a distance of 128 miles, of which about 22 miles was on the mainland and the remainder across the string of keys which

fringe the coast and extend to deep water at Key West.

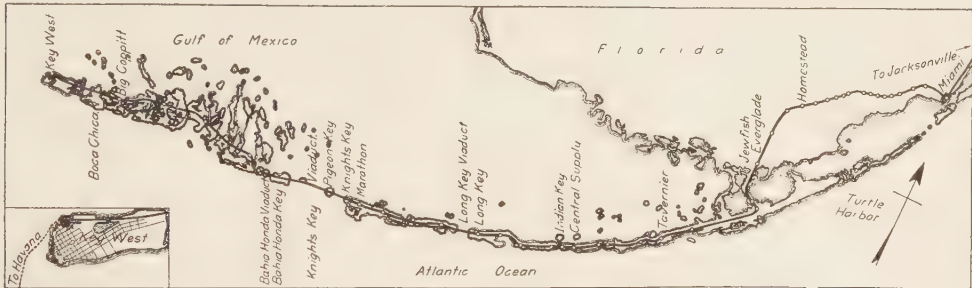
As far as Knight's Key the islands are admirably situated for the location of the railway, affording good alignment and necessitating comparatively little bridging, the longest stretch of water being at the lower end of Long Key where a concrete viaduct two miles in length was built. Immediately below Knight's Key is a stretch of water seven miles wide ranging in depth from 18 to 22 feet. A few miles further on Bahia Honda is encountered, where a bridge 5,100 feet long is required, in water whose greatest depth is 30 feet. The three structures just referred to, together with a concrete arch bridge, 2,573 feet long at Boca Chica, a few miles north of Key West, were the principal bridges as originally planned, although later it was found necessary to provide additional arch structures.

From the nature of the work practically all of the outfit used on the original construction was floating equipment and this included a number of Mississippi river steamboats of the stern-wheel type, which proved most efficient for the transportation of material and supplies in the shallower waters, owing to their light draft. All material and

supplies, including water for domestic and boiler use, had to be brought from the mainland. Material for concrete was shipped by steamer from northern points, trap rock being brought from the Hudson river, sand from Baltimore and American Portland cement from New York. German Portland cement was used in all concrete below high tide, being delivered by tramp steamers at the nearest available harbor.

On the keys proper most of the grading was done by hand labor. The material is coralline rock with little or no overburden of dirt. This rock is light and easily worked and

and sunk. Piles were then driven into the rock to refusal, the average penetration being 12 to 14 feet. The purpose of the piling was three fold: first, to afford foundation should any erosion of the rock occur; second, to act as an anchor against any tendency to overturning or lateral displacement; and third, to act as an exploratory probe. It happened several times that cavities in the rock were encountered that had been missed by the sounding outfits. After the piles were driven a footing course of concrete from 3 to 5 feet in depth was deposited by tremie and allowed to set, forming a seal. The cofferdam was then unwatered, the



KEY WEST EXTENSION OF THE FLORIDA EAST COAST RAILWAY

the quantities per mile averaged small. Where the embankments were too high to be built economically by hand labor the excavators were taken from their scows and placed on the embankment, moving forward on rollers as they completed the work ahead of them.

The Long Key viaduct is the longest structure of the arch type on the line and is a notable piece of work, consisting of 180 semi-circular arches of 50 feet span, the track being at an elevation of 30 feet above high tide. The method of construction used here has been followed on all similar work and a description of it will serve for all.

The location of piers having been established the sand was removed from the rock bottom by dredging and a cofferdam floated into place

piling cut off to a point well below low tide and forms erected for the piers. After the piers were completed to the springing line false work for the arch forms was driven and the forms put in place. To avoid expansion cracks the arches were put in alternately, the concreting being done by mixers and derricks on scows.

Below Knight's Key the rock changes from coralline to a highly fossiliferous sedimentary limestone, and it was found possible to use it for concrete, thereby effecting a saving in the cost of concrete of from \$3 to \$5 per cubic yard. The rock is blasted in shallow water and loaded by orange peel dredges. When blasted it breaks up into small sized pieces with enough fine stuff so that it can ordinarily be used as it comes

from the dredge without the addition of sand, or any sorting other than the removal of occasional large chunks.

Knight's Key bridge consists of 316 deck girders of 80-foot span and 19 deck girders of 59-foot 9-inch span, with 210 arches of 35-foot span at the southerly end where

bright yellow color corrosion is quickly detected. The ordinary galvanized telegraph wire rusts through in two years or less, and it even has been necessary to paint the track rails with a coating prepared by the Cunningham formula, consisting of one part kerosene, four parts Portland cement and 16 parts refined



LONG KEY VIADUCT OF CONCRETE—2.7 MILES LONG

shallower water is found, and a 253-foot 6-inch through-truss drawspan over Moser channel, the draw being operated by a gasoline engine.

Bahia Honda bridge consists of 13 spans of 128½ feet, 13 spans of 186 feet, 1 span of 247½ feet, and 9 80-foot plate girders. The decks of the steel bridges are of the ordinary type fastened with hook bolts.

The protection of the steel spans from rust is one of the hardest problems facing the railway. In the warm, moist, salty air corrosion begins in an almost incredibly short time, and no paint has been obtained that can be considered wholly satisfactory. Near the constructing engineer's office at Marathon a test rack is located in which are placed test plates coated with different paints, and so far none has been found that will afford protection for two years. The railway company's standard paint has proved about as efficient as any and on account of its

coal tar, the cement and kerosene being first mixed and then stirred into the heated tar. The concrete arch bridge at Boca Chica, four miles north of Key West, is the last important bridge on the extension, having 83 arches of 25-foot span.

The effect of sea water on the concrete has been closely watched, both in the actual structures and on test cubes exposed for observation, and so far there is no reason to believe that any serious deterioration will take place. Shortly after being exposed to the water it is found that a scaling off occurs to a depth of about one-sixteenth inch on the part of the concrete between the limits of high and low tide which amounts only to about 18 inches. After the scaling off has taken place a marine growth forms on the parts exposed to the water and seems to protect the concrete from further damage.

After surveys had been completed and plans made for the construction

of the extension it was thought that the bridges already referred to would be all that would be necessary and that solid embankments could be made from key to key in other places. However, there was one factor that had not been considered which has probably never been encountered in previous work of this kind. This is the impounding of the waters of the gulf by hurricanes in that pocket between the railway and the mainland known as the Bay of Florida. The hurricane of 1906, while very severe, came upon the work before those waterways had been closed, and it was not until the storms of 1909 and 1910 that their effects could be noted and studied in this connection. Under the stress of these storms continuing for several days from the south and west it was discovered that the water was banked up in the bay until it overtopped the embankments, and swept them away. It was also noted that the embankments across the water, even in the shallowest places, were the first to go, and that when they were gone the water rapidly subsided. This led to the decision to build arches, varying from 16 to 25 foot spans, across these stretches, the length required amounting to a total of between five and six miles.

From an operating standpoint the extension is in surprisingly good physical condition when one stops to

consider that in February, 1911, orders were given to have the line ready for traffic to Key West in January, 1912, instead of a year later, as had been the intention. The track is laid with 70-pound rail, well tied, with tie plates on all curves. The grade is practically level at a minimum elevation of about 10 feet above sea level except at Long Key, Knight's Key and Bahia Honda bridges where it is at a 30-foot elevation. On the bridges referred to speed is restricted to 15 miles per hour, to minimize the danger of derailment. For additional safety the despatcher's office is kept fully informed as to storm warnings and no train is allowed to proceed to exposed places when a hurricane is impending. Fortunately, severe storms are unusual except during the hurricane season.

Train service as scheduled provides two passenger trains and three freight trains each way daily except Sunday. One of the passenger trains is the "Oversea Limited," a solid Pullman train running between New York and Key West during the tourist season, and the other is a local from Jacksonville. The freight trains consist of one through freight one way freight and one water train, the water for the entire extension being hauled from Everglade on the main land where a pumping plant and storage tanks are maintained.

"WIRED WIRELESS" FOR MILITARY PURPOSES

A COMBINATION OF WIRED AND WIRELESS TELEGRAPHY IN FIELD SERVICE

Major George O. Squier—Journal Franklin Institute

PURE radio-communication is ideal for rapidly moving troops, but has the inherent defect that interference is always possible, and the information may un-

der certain conditions be received by the enemy. Radio methods and field wire methods, however, have taken their places as permanent means of electrical communication in war, and

while these two methods may be operated separately, yet it is possible to effect a useful combination of the two.

The standard Signal Corps field wire at present furnished consists of 11 strands of steel and one strand of copper, with a weight of about 70 pounds per mile and a resistance of about 11 ohms per mile. It is well known that electric waves are not transmitted as efficiently over iron wires as they are over copper wires. The greater the conductivity of the wire conductor, the less the line losses and hence the less the attenuation of the electric waves guided thereby. In addition, it is well known that in all experiments with high-frequency electric waves, where tuning to resonance is used, it is desirable that no iron should be employed. The results given below for field wire are, therefore, inferior to what would be obtained with copper conductors.

The latest apparatus of the Signal Corps for wireless sets employs a 500-cycle generator developed for use on aeroplanes and "pack" sets, with a specially designed transformer and a quenched spark gap as distinguishing features.

The coupling employed was inductive in type and variable within wide limits, permitting the voltage and the current impressed upon the line to be controlled at will. Convenient tuning elements were available for insertion in the line at the transmitting end. With this arrangement the general efficiency of transmission of electric waves along the ordinary type of field wire was observed, the actual wave-length being about 400 meters as measured by a wave meter.

Simple experiments showed that with a transmitting current of a few milliamperes loud signals were easily heard at the receiving end, using the

"perikon" detector supplied in the field pack sets, without the necessity of any tuning either at the transmitting or receiving end. When, however, an "audion" detector was substituted for a perikon it was noted that signals were heard when the receiving end of the wire was connected to one of the terminals of the audion, the other being entirely free, whereas, if the terminals were reversed, nothing was heard. The audion is a detector of the vacuum type in which an ionized path is provided between two insulated terminals inside the vacuum tube. Such a path is known to possess strong unilateral conduction for electric waves, and it was observed that when the free end of the wire was connected to the so-called "grid" terminal signals were heard, whereas they were entirely suppressed when the other terminal was used. The reason for this seems to be that when electric waves are guided along a wire to its free end, they are there reflected, the end of the wire becoming a node of current and loop of potential.

Since the audion is a type of detector which operates primarily on changes of potential rather than of current, the terminal connected to the end of the wire is subjected to changes of potential conforming to the signals transmitted along it, and these variations make themselves manifest in changes in potential along the ionic path which produce signals in the telephone. With the particular arrangement used, the signals were equally good with and without any earth connections to the detector.

The next experiment pertained to a No. 22 B. & S. paper insulated copper wire about seven miles long in conduit, which had a resistance of about 388 ohms. The distant end of this wire was left open. Electric waves of

a length of 7,500 meters, corresponding to 40,000 cycles per second, were developed by a high-frequency generator and were induced upon this line by loose inductive coupling.

Since the frequency of 40,000 cycles per second is above audition, it is necessary, in order to transmit telegraphic signals, to insert at the transmitting end an interrupter, breaking the series of continuous waves into groups or trains of a frequency within the limits of audition. This was done in the manner usually employed in wireless telegraphy, and the wave train period was approximately 1/1000 second, giving a clear musical note.

It is usual to insert the interrupter for the production of wave trains at the transmitting end of the line, but there are advantages in shifting this piece of apparatus to the receiving end. Accordingly, experiments were conducted to determine this point. With the interrupter shifted to the receiving end of the line, inaudible signals were sent out by making and breaking the line current of 40,000 cycles per second according to the dots and dashes of the Morse alphabet. Signals sent out in this manner were entirely inaudible at any point along the line, and can only be interpreted at a given point by inserting an interrupter whose function is to break up the otherwise inaudible trains of waves, corresponding to the periods when the key is closed at the transmitting end, into groups which can be heard. This experiment was entirely successful and offers the advantage that the line itself is never permitted to carry any current of audible frequency, so that chances of interference with neighboring lines are diminished and there is no possibility of detecting the signals by any of the usual means.

It was shown in the experiments that the standard form of quenched spark apparatus of low power is available for use on wire circuits, and, as these sets are comparatively inexpensive and are made in portable sizes of small power, they furnish an equipment immediately available for the use of "wired-wireless" on short lines.

It has been shown that the wireless telegraph equipment developed by the Signal Corps for use on aeroplanes or for communicating with mobile troops in the field, can be employed to create additional telegraphic channels of communication as follows:

(a) The standard insulated field wire furnished to the Signal Corps, when paid out on the ground and normally operated by the standard field buzzer, may be efficiently used to transmit Morse signals by electric waves by connecting it directly or inductively to the 500-cycle generator supplied for the wireless equipment, and the signals interpreted at the receiving end of the line by the standard low-resistance telephone.

(b) This same wire may also be used to guide the high-frequency electric waves transmitted by the complete field wireless quenched spark sending set and received by the complete wireless receiving set with the usual detector and high-resistance telephones. This gives three well-defined and distinctly separated methods of transmitting intelligence over wires, and permits the possibility of using them either separately or in any operative combination in accordance with the particular requirements of the case. The above results can be accomplished without the addition of a single piece of apparatus over what is already in the hands of the field companies of the United States Signal Corps.

DEEP ORE BODIES

DISCUSSION ON THE DECREASE IN VALUE WITH INCREASING DEPTH

F. Lynwood Garrison—Journal Canadian Mining Institute

ANYONE who has kept in touch with the trend of development in metal-producing and especially precious metal producing districts, must have noted with interest the repeated instances of discoveries of ore-bodies at relatively deep points in old mines, thus instilling new life to the neighborhood and affording encouragement to operators of mines similarly situated to explore and extend their deeper levels.

In directing attention to this important subject it must be recognized that the matter is one whose inherent difficulties may not be lightly disregarded and one in which unwarranted deductions might be drawn for promotion purposes or to deceive. It is but proper to say at the outset that payable ore deposits do not usually persist in great depth, in fact, in a geologic sense, they are essentially superficial phenomena. It is true mineralized fissures are known to extend to depths of 6,000 feet and probably much more, but it seems likely they will seldom be sufficiently rich to pay.

In this paper the author only contemplates such veins as have had their mineralized contents deposited by filling or replacing along fissures through which the metal-bearing waters and vapors have supposedly circulated.

Instances of the discovery of new deep-seated ore shoots are not uncommon in well established metal-producing districts where systematic exploration and development are being carried on. A number of such

cases might be cited, including the famous Comstock and some of the old mines on the Mother Lode in California. At Guanajuata, Mexico, the lower reaches of the Valenciana lode on the "Veta Madre" are to be tapped at a vertical depth of 2,000 feet below the collar of the Nueva Luz shaft, and about 3300 feet on incline from the top of the old Valenciana shaft, by new workings with a reasonable assurance of finding large bodies of payable ore.

It is evident there exists among experienced mining people a belief that in profoundly mineralized regions, it is reasonable to expect the deep sections of great vein systems will continue to yield abundantly of their treasures whenever the costs of exploration and extraction are not prohibitive. According to H. C. Hoover at Kalgoorlie, West Australia, there are several properties upon which ore bodies have been discovered in depth where none or but small ones existed at the surface. In another instance in this district a marked increase of value has been noted with depth. Recent experience at Tonopah, Nevada, tends to show a decrease in value with depth with a compensating tendency to wide lateral extent of pay ore in the veins, limited only by the characteristic block faulting of the district. However, it is not to be inferred from this that a vein or lode or series of veins are necessarily continuous laterally through the full extent of such a block. Evidently such is not the case, for the veins appear to cease laterally as they do in

depth even before being cut by a fault or intrusive dyke. But the practical point in this instance is that the chances of finding ore are overwhelmingly greater in lateral exploration than in vertical. It would seem that the deep underground circulation which concentrates metallic minerals at convenient voids in quantities sufficiently large to pay for extraction, is both upward and lateral, and that both seepage and capillary circulation contribute no small increment. That the metals now found in deep-seated ore deposits were derived wholly from indefinite depths is a theory difficult of complete acceptance, in view of the persistent and extensive mineralization usually encountered as incidental constituents of magmatic rocks, usually closely associated with precious metal deposits.

Anyone who has studied the precious metal deposits of our southwestern states and territories, of Mexico and especially in the great Andean region of Central and South America, must have been impressed by the highly mineralized character of the accompanying igneous rocks. To assume as probable a leaching of the metallic minerals contained in such rocks by aqueous solutions circulating laterally through them, by capillary attraction in the massive, and by seepage and flow in the fractures, followed by a subsequent deposition of the metallic burden in the adjacent voids or by replacement of rock and associated minerals, seems but a natural and logical conclusion. It is true that with the exception of iron the amount of metal found by analysis in such rock is usually exceedingly small, but we must realize that the volume of these rocks is very great compared with the size of the ore deposits, and that time reckoned by the geologic calendar is very long.

The old German miners recognized the value of pyrite as an indication of the proximity of ore; they gave the name "fahlbands" to zones or belts of pyritized country rock, and observed that fissures intersecting such zones are usually locally enriched.

Among the minor causes of enrichment of ore deposits near the surface is the mingling of solutions from cross fissures. Van Hise attributes the principal cause of ore shoots to them and it is indisputable that at such intersections ore bodies are common. But it does not appear that bonanzas or local enrichments in deep lodes are necessarily dependent upon such influences, in fact, deep-seated ore shoots are generally characterized by comparative dryness. As a rule the deeper one goes the less water there is; in other words, it would seem in most instances that after a certain level has been passed the amount of water encountered varies in inverse ratio with the depth, the deepest workings being the driest.

The most serious difficulties to overcome in deep mining are threefold—hoisting, high temperatures and rock pressure. The mechanical problem of hoisting from depths of 5,000 feet is probably the least of these, and has been pretty well worked out in South Africa, and at the copper mines of Lake Superior. When such shafts depart from the vertical in part of their course the best practice seems to be to hoist in stages.

The normal increase of rock temperature with depth is a more serious matter, although so far it has been capable of control, for while there is a steady rise of something like 1° Fahr. for each 208 feet (beginning with an average of 60° Fahr. at surface) of depth in the South African gold mines and 1° Fahr. for

each 103 feet in the Lake Superior copper mines, good ventilation overcomes much of the discomfort from this source.

The increase of rock pressure in deep workings is probably the most serious difficulty of all, one likely to make the methods of supporting the roof increasingly costly with depth. It seems likely that steel and concrete and especially waste rock filling may be used in such instances to marked advantage, where in higher levels timber would suffice. One

thing is certain, that in most cases, whatever methods are adopted, the expense is likely to increase out of all proportion to the profits. Moreover the outlook for a decrease of cost in this respect is not hopeful, unless it be in the direction of flushing with tailing sand and fine dump material. These methods or at least schemes of a somewhat similar character have been carefully studied and used in the anthracite coal district of Pennsylvania and in the gold mines of the Transvaal.

A RETURN AIR PUMPING SYSTEM

AN APPLICATION OF COMPRESSED-AIR DEVELOPING HIGH ECONOMY

Frank Richards—Power

IN the design of any compressed-air pumping system it is the general primary consideration that the volume of water to be pumped shall be displaced by an equal volume of air. Any difference of design of such systems being simply in the effectiveness of the application of the air and the method of discharging the water.

In the accompanying diagram, Figure 1 shows the general scheme of the ordinary design. The submerged chamber is assumed to have been filled with water and is being discharged. The air comes direct from the compressor, passes the automatic three-way valve—usually operated by a float, and enters the top of the chamber, its pressure driving the water up the vertical pipe at the right. When the water is all expelled, the three-way valve is changed to the other position, shutting off the compressed air and opening communication between the interior of the chamber and the atmosphere and allowing the air to escape. Then the valve in the water pipe at

the upper right-hand corner of the submerged chamber closes by its own weight and the pressure of the water above it, and the water rushes into the chamber through the valve at the bottom. A reversal of the three-way valve to the position shown puts the compressed air at work again and the content of the chamber is expelled as before, and so on.

It is well understood that the displacement pump does not use the air to good advantage, but for economy it is still much better than the air-driven, direct-acting pump. There is no friction of reciprocating parts and the clearance losses are very small.

The economy of the displacement pump is much better where the lift is small, which makes it specially applicable for transferring sewage and similar service, especially as the water may be loaded with a large proportion of solids and semi-solids without impairing its action.

While this type of direct air-pressure pump is effective, yet the fact that it does not use the air pressure

economically has eventually caused the design of a pump which shall return the unutilized portion of the air pressure back to the compressor.

This device can be explained in connection with the diagram in Figure 2. The return-air system is not as convenient in application as a steam pump, but is intended for large and permanent installations, each plant being complete in itself and doing no other work.

In the apparatus used is the ordinary, single-stage, reciprocating compressor, whose duty is to operate the one pump, the capacities of pump and compressor being adapted to each other.

The pumping part of the apparatus consists of two similar chambers to be alternately filled with water and emptied by the expulsion of the water to the level required. These chambers are submerged in the water to be pumped, or at least are located near and below the lowest working level of it, so that the water will always be able to flow into either chamber by gravity. The compressed air is conveyed to the pump from the compressor by separate pipes to each water chamber, and each pipe also leads the air, after its work of water expulsion is done, back to the air intake of the compressor. It is thus a closed system, and the same air is used over and over again, provision being made by continually replacing the little that may be lost by leakage or by absorption in the water. The valve arrangements are clearly shown in Figure 2.

The initial operation in filling the chambers and admitting the air is the same as in any displacement pump, and when the water is all, or nearly all, driven out the chamber is full of air at the pressure required and determined by the height of the

water delivery. In the return-air system, however, the air is not then allowed to escape, but is retained to do more work. The air is discharged from the water chamber and up the air pipe which, by the action of an automatic or a positively operated switch, is now in connection with the intake instead of the discharge of the compressor, and whatever pressure this air may have is thus always being exerted upon the intake side of the compressing piston, and the pressure upon this side

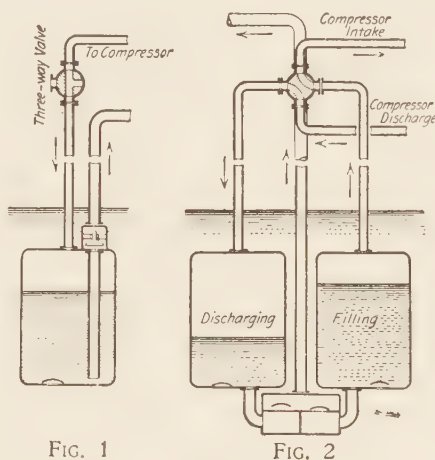


FIG. 1

FIG. 2

overcomes an equal amount of resistance upon the compressing side of the piston, or it deducts just so much from the total power required to drive the piston and to do the work of recompression.

Using the air in this way, its entire expansive force is retained until the air pressure is lower than that of the water, the difference in these pressures depending upon the speed at which the system is being driven. At this stage the water enters and drives the remainder of the air into the compressor intake at this pressure, instead of letting it expand further, and thus raises the total mean effective assisting pressure at the back of the piston above that

which would have resulted from the expansion alone.

Each return-pipe installation is an individuality, with special conditions to be satisfied and calling for special sizes and capacities, both relative and actual. The system is advantageously applicable to both extremes of the possible range of practical requirements, and to all between.

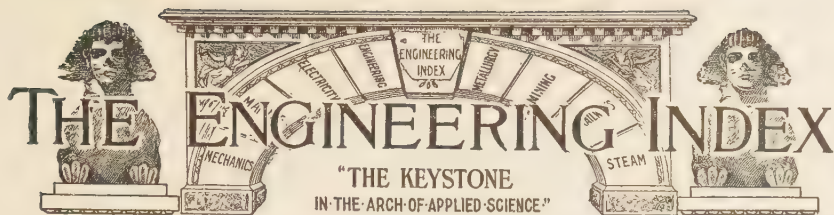
Where the lift is practically constant, as in raising water from a lake or river to a water-works reservoir, the compressor and the pump may be so adapted in capacity as to utilize all the expansive force of the air with comparatively little of the follow-up pressure from the water, but still with the highest possible ultimate efficiency and economy. In any case, as the compressor is in immediate touch with its work there is no loss from overcompression or from compressing above the actual requirement, as is often the case with the direct-displacement systems.

If the return-air system is employed where the level of the water intake has a considerable variation of height, as in emptying a large, deep shaft of a mine, the follow-up pressure of the water in refilling the operating chambers will vary constantly with the water level, and at all levels will approximately adjust the work of the compressor according to the actual water lift at the time; and, although the water must always be lifted under the full head at the time, and with the requisite over-balancing pressure for the expelling air, the compressing of the air to that pressure will require little or much power according to whether the return, or intake, pressure at the compressor is much or little, corresponding to the height of the water supply. With the direct displacement, and no return of the air, there would be none of this compensation,

either from the reëxpansion of the air or from the follow-up pressure of the incoming water, and all the water lifted, whether the level of the supply was high or low, would require the maximum and entirely uncompensated pressure to raise it.

In the foregoing outline of the operation of the return-air system reference has been made only to the action in one submerged operating chamber. It is understood that there are two similar chambers operated alternately, one filling while the other is emptying, so that the lifting is practically constant. The four-way valve or switch, as it is called, for reversing the connections of the two pipes at the proper times is operated in different ways according to the work. For a straight, steady water-works job the switch may be operated mechanically, tripping one way or the other for each given number of revolutions of the compressor; it may be operated automatically by the fluctuations in the level of the water supply, or by hand.

The actual installations of the return-air pumping system already show a wide and interesting range of successful employment; what the device needs most of all is to be better known. It seems to decline no work which is possible by any system, and it works for the lowest air output, and is especially successful in many lines which are not permissible to the formal mechanical devices. It pumps, for instance, water which is so charged with solid matter that it can only be called semi-liquid. It is in some cases regularly employed for conveying the solids so contained, as sand or marl, the mixture when so raised going to settling tanks where the water is allowed to flow off, leaving the solid portion to be shoveled or otherwise handled and conveyed wherever required.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

- (1) The title of the article,
- (2) The name of its author,
- (3) A descriptive abstract,
- (4) Its length in words,
- (5) Where published,
- (6) When published,
- (7) *We supply the article itself, if desired.*

 The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes’ time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one’s special interest.

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CIVIL ENGINEERING

BRIDGES

Arches

The Capital Avenue Bridge, Indianapolis, Ind. Illustrated description of the construction of this ornamental arch bridge of granite faced concrete. 1200 w. Munic Engng—April, 1912. No. 33109 C.

Bascules

Bascule Bridges Over Buffalo Ship Canal. Emile Low. Illustrates and describes interesting work required in the elimination of grade crossings, involving a railway, a highway, and a waterway. 2500 w. Ry Age Gaz—May 24, 1912. No. 33069.

The “Heel Trunnion” Bascule Bridge. Philip L. Kaufman. Illustrated detailed description of this new type of bascule bridge with fixed trunnions and overhead counterweights. 3000 w. Eng News—May 2, 1912. No. 32565.

Brooklyn Bridge

New Terminals for the Brooklyn Bridge. Illustrations and brief descriptions of proposed changes at both the Manhattan and Brooklyn ends. 1500 w. Eng News—May 9, 1912. No. 32686.

Concrete

Rapid Construction of a Small Concrete Bridge. P. E. Green. Detailed descrip-

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tion of the construction of a typical small highway bridge. Ills. 3000 w. Eng News—May 16, 1912. No. 32917.

Girders

Calculations for Railway Girders (Calcul d'une poutre de roulement) F. Moguet. Mathematical discussion on the triangular diagrammatic calculation of bridge girders with a dead load of 35 tons. Diagrams. 3800 w. All. Industrielle—May, 1912. No. 32764 D.

Peace Memorial

Proposed Peace Memorial Bridge. Two illustrations of a proposed bridge across the Niagara River between United States and Canada. 700 w. Can Engr—May 23, 1912. No. 33144.

Reconstruction

Bridge Reconstruction and Extension at Finsbury Park Station. Henry William Sadler. Illustrates and describes the first portion of alterations on the down-side at Finsbury Park, Great Northern Ry. 1800 w. Inst of Civ Engrs, No. 3943—May, 1912. No. 33162 N.

Reinforced Concrete

Recent Practice in Reinforced Concrete Bridge Building in the City of Pittsburgh. J. A. Ferguson. Explains the methods used in selecting the best types to meet conditions. Ills. General discussion. 16500 w. Pro Engrs' Soc of W Penn—April, 1912. No. 33120 D.

The Walnut Street Bridge, Des Moines, Iowa. Illustrated description of the construction of a reinforced concrete bridge, including the removal of an existing steel bridge. 2500 w. Eng Rec—May, 1912. No. 32585.

The First Reinforced Concrete Arch Bridge in Japan. Brief illustrated description of a bridge at Yokohama. 500 w. Eng News—May 9, 1912. No. 32688.

Strengthening

The Strengthening of Damodar Bridge on the Bengal-Nagpur Railway. Douglas Henry Remfry. Work made necessary by heavy coal traffic is described. Gives drawings. 1800 W. Inst of Civ Engrs No. 3893—May, 1912. No. 33168 N.

Substructure

The Substructure of the St. Louis River Bridge. Illustrated detailed description of substructure work for a 4-track steel viaduct and center swing bridge, near New Duluth, Minn. 2000 w. Eng Rec—May 25, 1912. No. 33080.

Viaducts

The Little Salmon River Viaduct, National Transcontinental Railway. R. F. Uniacke. Drawings and illustrated description of the design and construction. 5000 w. Can Soc of Civ Engrs—May, 1912. No. 33176 N.

The Little Salmon River Viaduct, National Transcontinental Railway. Illustrates and describes an interesting example of bridge work. 2200 w. Can Engr—May 23, 1912. No. 33143.

Viaduct across the Valley at Erbach, Westerwald (Talübergang bei Erbach, Westerwald). Herr Koester. Details in construction and design of the 292 m. reinforced concrete viaduct between Marienberg and Erbach. Ills. Serial, 1st part. 1700 w. Beton u Eisen—April 20, 1912. No. 32710 E.

CONSTRUCTION

Beams

The Stresses in Curved Beams. Ewart S. Andrews. Aims to obtain constants, based upon an analysis for rectangular sections, which will enable the designers to use the Pearson-Andrews theory without difficulty. 1000 w. Engr, Lond—April 19, 1912. No. 32464 A.

The True Bending Moments of Beams with Various Degrees of Fixity. Abstract from a paper by Maurice Behar, read before the Concrete Inst. Opposing the adoption of a method proposed for reinforced concrete work. 2000 w. Archt, Lond—April 19, 1912. No. 32509 A.

Building Construction

Superstructure of the Merchants and Manufacturers Exchange Building, New York. Drawings and description of a tall business building carried on a girder platform over the depressed tracks and yard of a great terminal station. 1500 w. Eng Rec—May 18, 1912. No. 32928.

Campanile

The Reconstruction of the Campanile in the Plaza of St. Marks, Venice. Charles A. Brassler. Illustrated description of the new tower and its erection. 2500 w. Am Archt—May 22, 1912. No. 33011.

Reinforced Concrete in the Campanile of San Marco (Il cemento armato nel Campanile di S. Marco). A. Danusso. Description of the method of application in the reconstruction of the St. Mark tower. Ills. and plate. 3500 w. Il Cemento—May 15, 1912. No. 32791 D.

Causeway

Galveston's Big Task Ended. Albert Phenis. Remarks on the significance of the completion of the great concrete causeway. Ills. 3000 w. Mfrs' Rec—May 23, 1912. No. 33038.

Cement

Building of Cement Plaster or Stucco Houses. P. P. Comoll. Gives suggestions as to construction with special regard to the ornamental features. 1700 w. Cement & Engng News—May, 1912. No. 32857.

Columns

The Theory of Columns. R. F. Deimel. Mathematical investigation. 700 w. Stevens Ind—Jan, 1912. No. 33023 D.

Concrete

Fabrication and Erection of Forms and Centers. Jerome Cochran. Treats of the fabrication and erection of forms based on current practice in concrete work.

6500 w. Cornell Civ Engr—May, 1912. No. 33197 C.

Concrete Fence Posts. L. J. Hotchkiss. Read before the Nat. Assn. of Cement Users. Reports experience with posts used by the C., B. & Q. Railroad. Ill. 1500 w. Can Engr—May 2, 1912. No. 32629.

Pre-Cast Concrete Residence Construction. Brief illustrated description of a residence at Woodmere (L. I.), N. Y. 900 w. Cement Age—May, 1912. No. 33097 C.

Pre-Cast Units in Economic Construction. Illustrates and describes examples of this construction. 1800 w. Cement Age—May, 1912. No. 33096 C.

Steel Forms and the Poured Concrete House. William Mayo Venable. Analysis of the advantages of steel over wood for this use. 2000 w. Cement Age—May, 1912. No. 33098 C.

See also **Factories and Foundations**, under *Construction*; *Concrete*, under *Materials of Construction*; *Concrete*, under *Roads and Pavements*, and *Subways*, under *STREET AND ELECTRIC RAILWAYS*.

Cost

Comparative Cost of Buildings of Wood, Concrete, and Steel Framing. Henry Grattan Tyrrell. A digest of comparative construction costs from many examples. First of three articles, deals especially with concrete buildings. Ills. 2500 w. Engineering Magazine—June, 1912. No. 33128 B.

See also **Labor**, under *Construction*.

Drainage

Plans for and Estimates of Costs of Draining 33000 Acres of Swamp Land in North Carolina. Map and plan of the ditch system for draining Back and Jacob's swamps. 2500 w. Engng & Con—May 15, 1912. No. 32912.

The Little River Drainage—A Project for Reclaiming 500,000 Acres of Swamp Land in Missouri. Map and description of a plan for reclaiming, by flood control and drainage, these swamp lands along the river. 1700 w. Engng & Con—May 8, 1912. No. 32658.

See also same heading, under **RAILWAY ENGINEERING**, *Permanent Way and Buildings*.

Earth Pressures

Notes and Experiments on Earth Pressures. James C. Meem. Describes experiments made and conclusions reached. 6000 w. Pro Engrs' Club of Phila—April, 1912. No. 33118 D.

Excavation

Hydraulic Excavation Methods in Seattle. R. M. Overstreet. Illustrates and describes features of the Jackson St. regrade work. 2500 w. Eng Rec—May 4, 1912. No. 32581.

Excavation Costs

The Cost of Rock Excavation in Open Cutting. Deals with the cost of excavating rock in open cutting, or exca-

vating rock for crushing, road-making, etc. 3500 w. Engr, Lond—April 26, 1912. Serial. 1st part. No. 32848. A.

Factories

Example of Concrete Factory Buildings. Illustrates and describes details of construction and design of the modern utilization of poured concrete in connection with light steel rods. 1000 w. Ir Age—May 25, 1912. No. 33056 C.

Foundations

Modern Testing of Foundations for Engineering Structures. Wallace T. Roberts. Describes methods and apparatus employed in modern prospecting. Ills. 3000 w. Jour Worcester Poly Inst—May, 1912. No. 33036 C.

Embankments and Foundations—Toronto-Sudbury Branch C. P. R. A. C. Oxley. Describes the construction of this line. 2200 w. Can Soc of Civ Engrs—May, 1912. No. 33178 N.

Constructing a Concrete Pile Foundation. Illustrates and describes foundations constructed for a warehouse in Pittsburgh. 900 w. Eng News—May 2, 1912. No. 32567.

Labor

The Cost of Labor in Connection with the Erection and Maintenance of Buildings. Abstract of a paper by R. M. Kearns read before the Surveyors' Inst. Suggestions for estimating the cost, based on British rates. 3500 w. Archt, Lond—April 19, 1912. No. 32510 A.

Reclamation

Tidal Marshes and Their Reclamation. George M. Warren. Illustrated account of investigations and study of the profitable reclamation of tidal marshes. 99 pages. U S Dept of Agri, Bul 240—Oct. 3, 1911. No. 32897 N.

See also **Drainage**, under *Construction*.

Reinforced Concrete

Field Testing and Inspection on Reinforced Concrete Building Contracts. Describes methods followed on the construction of several Brooklyn warehouses. 3500 w. Eng Rec—May 11, 1912. No. 32814.

Reinforced Concrete Curved Surfaces and Their Anchorage (Les Surfaces Courbes et les Ancrages dans le béton armé). M. Mesnager. Discussion on the method of tying curved corners in reinforced concrete construction. Ills. 4000 w. Génie Civil—April 20, 1912. No. 32777 D.

See also same heading under *Bridges*; *Campanile* under *Construction*; and *Water Towers*, under *Water Supply*.

Rock Crushing

Rock Crushing Plant, Kensico Dam. Samuel W. Traylor. Illustrated description of this crushing plant to prepare stone for this dam being built in connection with the new water supply for New York City. 2200 w. Cement & Engng News—May, 1912. No. 32858.

Stacks

The Design of a Brick Chimney. J. Norman Jensen. Gives general principles to be applied and details of computations necessary for the design of a brick chimney 125 ft. in height. 3500 w. Eng News—May 9, 1912. No. 32681.

Steel

The Steel Substructure of the Merchants and Manufacturers Exchange Building. Drawings and description of the construction of a 12-story building over the N. Y. C. & H. R. R. R. yard in New York City. 3000 w. Eng Rec—May 11, 1912. No. 32811.

Tunnels

Lining a Tunnel in Swelling Rock. Guy R. McKay. Illustrates and describes methods used on the Snake Creek tunnel in Utah. 3000 w. Eng Rec—May 25, 1912. No. 33073.

Arthur's Pass Tunnel, New Zealand. W. H. Gavin. An illustrated description of a 5½ mile railway tunnel through a mountain range, under construction by American machinery and partly under direction of American engineers. 5000 w. Eng News—May 9, 1912. No. 32682.

Methods of Constructing the Beacon Hill Rapid Transit Tunnel, Boston, Mass. Sketches and description. 1200 w. Engng & Con—May 22, 1912. No. 33041.

Tunnel Lining, Catskill Aqueduct. M. E. Zipser. Drawings and detailed description of this work, which has proved most successful. 11000 w. Eng News—May 2, 1912. No. 32564.

Methods of Constructing the Rondout Pressure Tunnel of the Catskill Aqueduct. From a paper by Lazarus White, read before the Soc. of Munic. Engrs. of N. Y. Illustrates and describes methods of driving, concreting, etc. 5000 w. Engng & Con—May 22, 1912. No. 33042.

Methods of Shaft Excavation in Earth at the Rondout Pressure Tunnel of the Catskill Aqueduct. From a paper by Lazarus White, before the Soc. of Munic. Engrs. of N. Y. Describes the methods adopted in driving the working shafts. 3000 w. Engng & Con—May 8, 1912. Serial. 1st part. No. 32653.

The Laramie-Poudre Tunnel. Discussion of Burgis G. Coy's paper. 6000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33223 F.

Underpinning

Underpinning Buildings Adjacent to the Lexington Avenue Subway in New York. Describes 5-story brick walls carried on steel needles and jackscrews and new footings while piers and girders are built under them. Ills. 2500 w. Eng Rec—May 11, 1912. No. 32813.

MATERIALS OF CONSTRUCTION**Cement**

Making Indestructible Hydraulic Cements. Edward Duryee. Information concerning cements and their durability.

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A Summary of Recent Investigation of Portland Cement. J. C. Bishop. 2500 w. Sib Jour of Engng—May, 1912. No. 33205 C.

United States Government Specifications for Portland Cement. Gives the specifications as adopted by the departmental conferences, Feb. 13, 1912. 3000 w. Chem Engr—May, 1912. No. 33136 C.

See also same heading, under *Construction*.

Concrete

The Lateral Pressure of Liquid Concrete. Hector St. George Robinson. Brief report of experiments. 600 w. Inst of Civ Engrs, No. 3975—May, 1912. No. 33160 N.

A Study of Sand for Use in Cement Mortar and Concrete. E. S. Larned. Gives results of mechanical analysis and comparative tensile tests of sands and much information. General discussion. 3500 w. Jour Assn of Engng Socs—April, 1912. No. 33115 C.

Proportioning Gravel Concrete. Clifford Older. From a paper before the Ill. Soc. of Engrs. & Survs. Describes specifications for gravel concrete in use by the Illinois Highway Commission for several years. 1800 w. Munic Engng—April, 1912. No. 33104 C.

See also same heading under *Construction*.

Materials

Address of William Cawthorne Unwin. Discusses some of the principles on which engineering structures are based; the strength of materials, theory of elasticity, testing, applications, value, etc., with remarks on engineering education. 29 pages. Inst of Civ Engrs. Nov. 7, 1911. No. 33171 N.

Paint

What Makes White Lead Chalk and How Chalking May Be Prevented. Henry A. Gardner. Read before the Penn. State Assn. of Master Painters. Discusses recent theories and states conclusions. 1500 w. Chem. Engr—May, 1912. No. 33137 C.

Reinforced Concrete

The Reinforced Concrete Specialist in England. Lucien Serrailier. Considers the opportunities for the architect in the use of this material. 2500 w. Cement—March, 1912. No. 32608 C.

See also same heading under *Bridges and Construction*.

Reinforced Concrete Beams

The Performance of Fixed or Continuous Reinforced Concrete Beams under the Eichholz System for Constructing with Increasing Pressure Dimension (Die Ausführung des eingespannten oder kontinuierlichen Eisenbetonträgers mit wechselndem Druckgurt nach dem System Eichholz). Herr Schnellnegger. Experi-

ments showing that a load is taken care of by increased size of beam, when distance from support increases. Ills. 3600 w. Beton u Eisen—April 20, 1912. No. 32712 E.

Stucco

Metal Lath in Residence Construction. H. B. McMaster. Explains the advantages of this material in stucco construction and comparative costs. 1200 w. Cement Age—May, 1912. No. 33099 C.

See also Cement, under *Construction*.

Timber

Wood-Using Industries and National Forests of Arkansas. Part I. Uses and Supply of Wood in Arkansas. J. T. Harris and Hu. Maxwell. Part II. Timber Resources of the National Forests in Arkansas. Francis Kiefer. 40 pages. U S Dept of Agri, Bul. 106. No. 33184 N.

Timber Preservation

See Timbering, under MINING AND METALLURGY, *Mining*.

MEASUREMENT

Clay Testing

The Testing of Clay Refractories, with Special Reference to Their Load Carrying Capacity at Furnace Temperatures. A. V. Bleining and G. H. Brown. Deals with refractoriness or fire clays and their viscosity at furnace temperatures. Ills. 78 pages. Bureau of Stand, Tech. paper No. 7—Dec. 15, 1911. No. 33172 N.

Flexure

Faults in the Theory of Flexure. Discussion of Henry S. Prichard's paper. 45000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33224 F.

Stress

The Distribution of Stress in Certain Tension Members. C. Batho. Describes experiments and tabulates results by strain measurements with the Martens extensometer to determine the distribution of stress. Ills. 8800 w. Can Soc of Civ Engrs—May, 1912. No. 33177 N.

Surveying

Notes on a System of Surveying with a Tacheometer. Herbert George Dempster. Describes apparatus developed with the object of reducing the labor in the field, and to enable the field books to be worked out by a mechanical method. Ills. 2000 w. Inst of Civ Engrs, No. 3954—May, 1912. No. 33166 N.

Adjustable Wires for Stadia Surveying. Ernest McCullough. A report of the writer's experience and reasons for using adjustable wires. 2500 w. Eng Rec—May 11, 1912. No. 32810.

Retracement-Resurveys—Court Decisions and Field Procedure. Continued discussion of N. B. Sweitzer's paper. 9000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33222 F.

Wind Pressure

Wind Pressure Against Inclined Roofs. H. P. Boardman. Describes experiments

and discusses results. General discussion follows. Ills. 8800 w. Jour W Soc of Engrs—April, 1912. No. 33111 D.

MUNICIPAL

Catch Basins

Catch Basins for Sewer Inlets. Gives opinions of a number of city engineers as to desirability of using them. Ills. 22000 w. Munic Jour & Engr—May 2, 1912. No. 32549.

City Planning

Competitions for a City Plan in Waidareals in Zürich (Wettbewerb für einen Bebauungsplan des Waidareals in Zürich). Illustrated review of some of the plans submitted. 2500 w. Schweiz Bau—Apr. 27, 1912. No. 32715 D.

Drainage Canal

Papers Relating to the Application of the Sanitary District of Chicago for Permission to Divert 10,000 Cubic Feet of Water per Second from Lake Michigan. Statements showing the dangers that threaten navigation and allied interests of the Great Lakes and St. Lawrence River. 270 pages. Dept of Marine & Fisheries, Canada—May, 1912. No. 33181 N.

Protest Against Further Diversion of Water from Lake Michigan for the Chicago Drainage Canal. Presented at Washington, March 27, 1912. Map. 6000 w. Can Com of Conservation—May, 1912. No. 33182 N.

Exmouth, Eng.

Exmouth: A Decade of Progress in a Residential Seaside Town. Samuel Hutton. Read before the Inst of Munic & Co. Engrs. Describes the roads, bridges, sewerage, refuse disposal, waterworks, sea defence, etc. Ills. Short discussion. 5000 w. Surveyor—May 10, 1912. No. 32976 A.

Fire Prevention

Practical Fire Prevention. Edward F. Croker. Presents the fundamental principles of an effective service. 2500 w. Engineering Magazine—June, 1912. No. 33129 B.

Public Service

Municipal Chemistry. J. H. Coste. Indicates the classes of service rendered by chemists to local authorities and considers the qualifications required. General discussion. 8000 w. Jour Soc of Arts—April 19, 1912. No. 32511 A.

Refuse

Methods of Handling House Refuse Before Collected by the City. Gives the recommendations of Samuel A. Greely, given before the New Jersey Sanitary Assn. Favors the one-can system. 1800 w. Engng & Con—May 15, 1912. No. 32911.

Clearing the City Refuse of Paris (L'Evacuation des Ordures Ménagères a Paris). P. Labordère. Description of the large automobile trucks with 6 cubic meter capacity used by the street clean-

ing department, and their efficiency. Ills. 4000 w. Génie Civil—April 13, 1912. No. 32774 D.

Run-Off

Run-Off from Sewered Areas. L. K. Sherman. Data on the run-off from certain sewered areas in the south part of the city of Chicago. Discussion. Ills. 4500 w. Jour W Soc of Engrs—April, 1912. No. 33112 D.

See Catch-Basins, under *Municipal*.

Sanitation

Sanitary Conditions at Key West. James Nisbet Hazlehurst. Explains the geological conditions, the proposed sewer system, and the unusual sanitary conditions. Ills. 1500 w. Munic Jour—May 9, 1912. No. 32673.

Sewage Disposal

Chemical Disinfection of Sewage. Earle B. Phelps. Reports Results of large scale experiments on use of hypochlorites. 3500 w. Munic Jour & Engr—May 2, 1912. No. 32548.

Notes on the Digestion of Sewage Sludge. Charles Saville. Discusses the advantages and disadvantages of separate sludge digestion tanks. 3000 w. Eng Rec—May 25, 1912. No. 33077.

Progress in Canada in Biological Methods of Sewage Disposal During the Last Twenty Years. Willis Chipman. Read before the Can. Pub. Health Assn. Reviews the progress of sewage purification. 3000 w. Can Engr—May 2, 1912. No. 32632.

Residential Sewage Disposal Plants. R. Winthrop Pratt. From a paper before a conference of boards of health. Considers the general principles governing the design of such plants. Ills. 1500 w. Munic Engng—April, 1912. No. 33106 C.

The Design of Institutional Sewage Disposal Plants, with Special Reference to Plants at the Infirmary and the Children's Home of Greene County, Ohio. A. Elliott Kimberley. Illustrated detailed descriptions. 3000 w. Engng & Con—May 8, 1912. No. 32656.

Institutional Sewage Disposal Plants. A. Elliott Kimberly. Illustrates and describes their design and construction, with special reference to the plants at the infirmary and children's home of Greene Co., Ohio. 3000 w. Dom Engng—May 25, 1912. No. 33135.

Proposed Joint Sewage Purification Works for Orange, Montclair and East Orange, N. J. Information concerning an interesting sewage disposal works intended to produce a high-grade effluent. 1800 w. Eng News—May 9, 1912. No. 32689.

Worcester's Sewerage and Sewage Disposal. Information from the last annual report concerning the operation of sand filters, experiments with Emscher tank, sprinkling filters, etc. 6000 w. Munic Jour & Engr—May 2, 1912. No. 32546.

Sewage Treatment of the Experimental Plant in Worcester. Information from the report of Matthew Gaults, superintendent of sewers, for the year ending Nov. 30, 1911. 2500 w. Eng Rec—May 18, 1912. No. 32931.

The Sewage Disposal Works at Lebanon. Illustrates and describes a plant installed in Pennsylvania to prevent pollution of a stream used for water supply. 2200 w. Eng Rec—May 4, 1912. No. 32588.

Sewage Pumping

Chattanooga Sewage Pumping Station. Robert Hooke. Illustrated description of a pump well forty-seven feet deep, operated by automatically controlled A. C. Motors. 1600 w. Munic Jour & Engr—May 2, 1912. No. 32547.

Smoke

Prevention of Smoke by Combustion. Describes the addition of fireclay tubes in the furnace to retain heat for burning distilled gases. Ills. 2000 w. Mines & Min—May, 1912. No. 32538 C.

ROADS AND PAVEMENTS

Asphalt

Costs of Constructing and Maintaining Petrolithic Roads and Streets, Together with Data on Other Liquid Asphalt Roads. K. F. Postle. Information concerning roads in California. Ills. 2200 w. Engng & Con—May 1, 1912. No. 32554.

Bitumens

Use of Bitumens for Roads. Arthur H. Blanchard. Read before the Am. Assn. for the Adv. of Science. A review of the use of bituminous materials in the construction and maintenance of American highways during 1911. 4000 w. Munic Jour—May 16, 1912. No. 32937.

Concrete

Methods and Cost of Constructing Concrete Combined Curb and Gutters and Concrete Sidewalks. E. W. Robinson. Report of work in Webb City, Mo. 3000 w. Engng & Con—May 15, 1912. No. 32909.

Portland Cement Concrete Roads. Logan Waller Page. Read before the Am. Assn. of Portland Cement Mfrs. Believes concrete can be made generally successful if sufficient care is used in the selection of materials and construction. 2500 w. Eng Rec—May 25, 1912. No. 33078.

Concrete Pavements in Davenport, Iowa. A. M. Compton. Read before the Iowa Engng Soc. Reports results and experience with reinforced concrete pavement, and describes present practice. 2200 w. Eng Rec—May 4, 1912. No. 32582.

Construction

The Contractors' Side of Road Building. D. L. Hough. From a paper before the Am. Assn. for Highway Imp. Discusses difficulties and offers sugges-

tions. 3500 w. Munic Engng—May, 1912. No. 33193 C.

The Economy of Good Roads. Victor Hart. Considers the principles of Roman road building, Macadam's method, modern roads for automobiles, etc. Map. 3000 w. Horseless Age—May 8, 1912. Serial. 1st part. No. 32672.

Stone and Gravel Roads. W. A. McLean. Read before the Am. Road Bldrs. Assn. Information concerning roads in Ontario, Canada, their construction, maintenance, etc. 3500 w. Munic Engng—May, 1912. No. 33195 C.

Road Construction and Maintenance. An informal discussion on materials, etc. Ills. 11800 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33226 F.

Highways

Mass and Bulk in Highway Engineering. Explains the value of these two primary factors in the mechanics of road crusts. 2000 w. Surveyor—May 10, 1912. No. 32977 A.

New York State Highways. An illustrated account of the organization, methods of maintenance, types of construction and details. 9000 w. Munic Jour—May 16, 1912. No. 32936.

Street Grades

A Proposed Method of Interpreting the Elevations of All Portions of Street Surface from the Established Grades. Herman S. Moore. Abstract of paper read before the Munic Engrs of N. Y. City. Outlines the proposed method and its application. 8000 w. Engng & Con—May 8, 1912. No. 32655.

Street Sprinkling

Street Sprinkling in St. Paul, Minn. C. L. Annan. Explains the method adopted, assessing the cost, etc. Ills. 2000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33217 F.

Street Sweeper

A Motor-Driven Pneumatic Street Cleaning Machine. Illustrated description of a power machine of the vacuum-cleaner type. 1200 w. Eng News—May 2, 1912. No. 32563.

Surfacing

Practical Road Building. John N. Edy. The present number discusses sand-clay roads. 1500 w. Munic Engng—April, 1912. Serial, 1st part. No. 33103 C.

Bitucrete Pavement. A. E. Schutte. Explains the problems in constructing roads to stand both horse and motor traffic, and gives results with this material, describing method of construction. 2200 w. Munic Engng—April, 1912. No. 33108 C.

Wood Blocks

The Testing of Wood Paving Blocks. F. Kleeberg. Information concerning the requirements for such blocks in Manhattan, the tests and experiments made on deliveries and related matters. 3000 w. Munic Engng—May, 1912. No. 33191 C.

Wood Block Pavements from Construction Standpoint. Day I. Okes. Read before the Wood Preservers' Assn. Considers the construction of creosoted block pavement. 1200 w. Munic Engng—April, 1912. No. 33107 C.

Methods and Cost of Constructing a 3-in. Creosoted Wood Block Pavement at Longview, Texas. P. E. Green. A report of the work. 2500 w. Engng & Con—May 15, 1912. No. 32908.

WATER SUPPLY

Aqueducts

An Aqueduct Two Hundred and Forty Miles Long. Burt A. Heinly. Illustrations and brief description of the steel and concrete siphons which will supply Los Angeles with water. 700 w. Sci Am—May 25, 1912. No. 33047.

Dam Failures

Failures of the Dalton Concrete Core-Wall Dam, Mineville, N. Y. Illustrated description of this dam and its failure. 1200 w. Eng News—May 9, 1912. No. 32690.

Dams

A Review of Masonry Dam Design and Construction, Illustrated with Cross-Sections of Forty Notable Dams. 8500 w. Engng & Con—May 22, 1912. No. 33044.

Provision for Uplift and Ice Pressure in Designing Masonry Dams. C. L. Harrison's paper is discussed. 2500 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33220 F.

The Analytical Determination of the Dimensions of the Gravity Resisting Parts of Masonry Dams. Maurice G. Parsons. Presents formulae for dimensioning multiple-arch dam buttresses. 3000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33216 F.

Elements of Hydro-Resistant Construction and Development of Ultimate Type of Dam. George E. Ladshaw. An outline study. 1000 w. Cornell Civ Engr—May, 1912. No. 33199 C.

Method and Cost of Solidifying Fissured Rock by Grouting, Estacada Dam, Oregon. Herman V. Schreiber, in paper before the Nat. Assn. of Cement Users. Describes the grouting of fissured rock for the foundation of a concrete dam. 2000 w. Engng & Con—May 8, 1912. No. 32654.

Raising the Sweetwater Dam. Illustrates and describes the method used in raising and reinforcing this masonry dam in California. 1500 w. Munic Jour—May 23, 1912. No. 33062.

The Construction of La Boquilla Dam, Mexico; Difficulties Due to Revolution. William B. Fuller. Illustrated account of this large masonry dam. 1100 w. Engng & Con—May 22, 1912. No. 33040.

The Lahoutan Dam on the Truckee Carson Irrigation Project. Illustrates a dam of the earth and gravel fill type with riprapped slopes, describing its construc-

tion. 1200 w. Eng Rec—May 18, 1912. No. 32929.

The New Loch Raven Dam at Baltimore. A solid masonry dam provided with drainage systems to prevent seepage through the masonry and the upward pressure at the base. Ills. 1500 w. Eng Rec—May 25, 1912. No. 33076.

A Western Type of Movable Weir Dam. W. C. Hammott. Illustrates and describes this type of dam, rather common in California, discussing the forms in detail. 1500 w. Pro Am Soc of Civ Engrs—May 1, 1912. No. 33219 F.

Ditch Sections

Design of Channels and Ditches of Trapezoidal Sections. H. S. Chuck. Diagrams and explanation of method of determining the proper size or dimensions of a channel. 1500 w. Cornell Civ Engr—May, 1912. No. 33198 C.

Filtration

Construction of the Minneapolis Filters. W. N. Jones. Illustrated description of the methods used on a force account undertaking. 5000 w. Eng Rec—May 18, 1912. No. 32926.

The Evansville Water Filtration Plant. Illustrated description of a purification plant resting on reinforced piles and having novel features of interest. 3000 w. Eng Rec—May 11, 1912. No. 32807.

Fire Protection

Management of High Pressure Fire Systems. Committee report presented at the annual convention of the Nat. Fire Protection Assn. 2200 w. Eng Rec—May 25, 1912. No. 33079.

Irrigation

Some Structures and Construction Methods on an Irrigation Project in Sacramento Valley, California. Illustrates and describes this project which will furnish water for 130,000 acres of land. 2500 w. Cornell Civ Engr—May, 1912. No. 33196 C.

The Bow Valley Irrigation Works of the Canadian Pacific Railway Company in Alberta. A. S. Dawson. Map and illustrated description of this extensive development. 4000 w. Engng & Con—May 1, 1912. No. 32556.

Meters

Water Meters, Mains and Service Pipes from the Financial Standpoint. Willis J. Spaulding. From a paper before the Ill. San. and Water Supply Assn. Reports results of metering the service, the necessity of testing the meters, rate, extensions, and other financial points are considered. 2000 w. Munic Engng—April, 1912. No. 33105 C.

Pipe Corrosion

Corrosion of Artesian Well Casing in New South Wales. An account of the corrosive action of the Coonamble bore waters and the efforts to find a casing that will resist it. 2000 w. Eng Rec—May 18, 1912. No. 32927.

Pipe Protection

Protecting Pipe Lines Against Alkali. C. P. Bowie in Western Engng. A problem in the western part of the United States to adequately protect pipes against alkaline soils is discussed. 1700 w. Can Engr—May 23, 1912. No. 33142.

Pollution

The Prevention of the Pollution of Canadian Surface Waters. T. Aird Murray. On the necessity of federal control; typhoid fever and stream pollution; and sewage purification and sterilization. 4000 w. Can Com of Conservation—May, 1912. No. 33183 N.

Pumping Stations

Some Economic Considerations Affecting the Design of the Power Plant for Water Works Pumping Stations. A study based on a paper by Nicholas S. Hill, before the Munic Engrs of N. Y. City. 4000 w. Engng & Con—May 8, 1912. No. 32657.

The Rebuilt French Pumping Stations. C. A. Tupper. Brief illustrated description of stations at Lyons, France. 900 w. Eng News—May 9, 1912. No. 32684.

Purification

The Purification of Water Supplies. Reviews the Seventh Research Report by Dr. A. C. Houston, Director of Water Examination to the Metropolitan Water Board, dealing with investigations of the effect of storage of river water, and other subjects of related interest. 2200 w. Engr, Lond—May 3, 1912. No. 32888 A.

The Value of Pure Water. Charles B. Burdick. From a paper before the Indiana San. & Water Supply Assn. Review of what has recently been accomplished in furnishing pure water to cities and the cost. 2000 w. Munic Engng—May, 1912. No. 33194 C.

Experimental and Permanent Plants for Applying Bleach at Kansas City, Mo. Burton Lowther. Illustrates the temporary experimental plant and the new hypochlorite plant, stating results. 2200 w. Eng Rec—May 18, 1912. No. 32930.

The Design and Cost of the Permanent Hypochlorite Disinfecting Plant at International Falls, Minn. J. A. Childs. Illustrated description of the plant as constructed. 1000 w. Engng & Con—May 15, 1912. No. 32910.

New Water Purification Works at Otumwa. Illustrated description of the replacing of modern tanks by concrete filters. 2000 w. Eng Rec—May 4, 1912. No. 32586.

Reservoirs

A 1,300,000-Gallon Concrete Reservoir. E. W. Robinson. Discusses the design, construction and cost of a new structure in Webb City, Missouri. 2200 w. Eng Rec—May 11, 1912. No. 32812.

Singapore

Singapore Waterworks Extensions. Illustrates and describes extensions com-

prising extensive reservoir and filters, the construction. 3000 w. Surveyor—May 3, 1912. No. 32876 A.

Sterilizing

An Electrolytic Sterilizing Plant. Diagram and brief description of an electrolytic sodium hypochlorite sterilizing apparatus. 800 w. Elec Rev, Lond—April 26, 1912. No. 32828 A.

Waste

Water Waste Surveys at Chicago. Map and account of conditions, describing a survey to detect waste and leakage and its results. 4000 w. Eng News—May 9, 1912. No. 32685.

Water Power

Hydraulic Power. Joseph Horner. This first article of a serial considers the general utilities of hydraulic mechanism. Ills. 3500 w. Cassier's Mag—May, 1912. Serial. 1st part. No. 33028 B.

Water-Power Development in the United States. Abstract of a recent report to President Taft with editorial note. 4000 w. Elec Wld—May 11, 1912. No. 32802.

Utilizing Water Power at the Cincinnati Filtration Plant. J. S. Gettrust. Illustrates and describes the general arrangements. 1500 w. Eng Rec—May 4, 1912. No. 32583.

Water Power Development at Keokuk, Iowa. Illustrates and describes an installation for utilizing the power from the Des Moines Rapids of the Mississippi River. 2500 w. Cement & Engng News—May, 1912. No. 32856.

I. The Loch Leven Water-Power Works. Alfred Henry Roberts. No. 3932. II. The Hydro-Electric Plant in the British Aluminium Company's Factory at Kinlochleven. Frederic Bolton Sonnenschein. No. 3925. With an abstract of the discussion on the papers. Descriptions with illustrations. 116 pages. Inst of Civ Engrs—May, 1912. No. 33170 N.

Water Towers

The Design and Construction of a 100,000-Gallon Reinforced Concrete Water Tower and Tank. Illustrated detailed description of a structure in Chicago. 3000 w. Engng & Con—May 22, 1912. No. 33043.

Water Works

Further Notes on the New Lanarkshire Middle-Ward District Waterworks. John McNee. Describes the supply, giving information concerning the raising of the level of Glengavel reservoir, and the mechanical filtration. 3000 w. Inst of Civ Engrs. No. 3948 — May, 1912. No. 33164 N.

Report on the Sanitary Efficiency of the Philadelphia Water Works. From a report of Hollis Godfrev. 3000 w. Eng News—May 23, 1912. No. 33068.

Weirs

The Movable Diversion Weir at Beremb. Illustrated description of the sluices

and wickets and the method of operating them. 2500 w. Eng Rec—May 4, 1912. No. 32584.

WATERWAYS AND HARBORS

Antwerp

Improvement to the Port of Antwerp. Notes from *Les Ann. des Travaux Pub. de Belgique*, discussing the projects now under consideration in this port. Maps. 2000 w. Engr, Lond—May 10, 1912. No. 32992 A.

Barge Canal

The Irondequoit Creek Concrete Trough. H. J. Knoppel. Illustrates and describes a reinforced concrete waterway built on a high fill to carry the N. Y. State Barge Canal near Pittsford. 1500 w. Eng Rec—May 11, 1912. No. 32809.

Breakwaters

The Construction of Breakwaters in Modern Maritime Ports (*La struttura dei moli nei porti marittimi moderni*). L. Figari. Mathematical and diagrammatical methods for determining the size and thickness of breakwaters, jetties and piers. Ills. 8000 w. Ann della Soc d Ing e d Arch Ital—Apr. 16, 1912. No. 32789 E.

Canales

See Drainage Canal, under *Municipal*.

Chicago

Chicago's Waterways in Their Relation to Transportation. George A. Zinn. General discussion of the relation between waterways and transportation, and the terminal facilities needed. Discussion. 22500 w. Jour W Soc of Engrs—April, 1912. No. 33110 D.

Drainage

See same heading under *Construction*.

Dredging

Largest Dredging Plant in the World. Information concerning the fleet owned by the United States Government and engaged on river and harbor work. 4000 w. Eng News—May 9, 1912. No. 32687.

See also Dredges, under MARINE AND NAVAL ENGINEERING; and Dredging, under MINING AND METALLURGY, *Gold and Silver*.

Floods

What Is the Remedy for Mississippi Floods? Editorial on the suggestions appearing in recent articles, and the monograph by William Starling, published in 1897, with general discussion of the problem. 3000 w. Eng News—May 23, 1912. No. 33067.

Grader

Test of a Mississippi River Suction Grader. Thomas C. Allen. Illustrated description of an equipment for grading the banks of the Mississippi, with report of test. Ills. 1200 w. Int Marine Engng—May, 1912. No. 32595 C.

Inland Waterways

The Atlantic Coast Waterway. Reports results of an investigation of the project for an inland waterway from Boston to

Beaufort Inlet, N. C. Maps. 4000 w. Eng News—May 16, 1912. No. 32919.

Ore Transport

All-Water Transport of German Iron Ore. Stuart Rice. Brief account of what has been done in Germany to furnish cheap water freightage for ore. Ills. 1500 w. Min & Engng Wld—May 11, 1912. No. 32820.

Sea Walls

See Causeways, under *Construction*.

Shore Protection

Concrete Mattress Bank Protection. Describes a mattress made of concrete blocks tied together with wire which has proved very successful on the Yulari River, in Japan. Ills. 2500 w. Eng News—May 16, 1912. No. 32918.

A New Protection for River and Railway Banks (Ein neuer Ufer- und Böschungsschutz). Anton Fitzinger. Describes a process for tying and anchoring concrete blocks in revetment work. Ills. 1800 w. Beton u Eisen—Apr. 20, 1912. No. 32711 E.

Southampton

Port of Southampton. Mark Meredith. An illustrated account of the development of this important English port. 3500 w. Cassier's Mag—May, 1912. No. 33025 B.

Water-Fronts

The Problems of the Lower West Side Manhattan Water-Front of the Port of New York. Continued discussion of the paper by B. F. Cresson, Jr. 4000 w. Pro Am Soc of Civ Engrs—May, 1912. No. 33221 F.

Wave Impact

Wave Impact on Engineering Structures. Arnold Hartley Gibson. Report of investigations and conclusions. 5500 w. Inst of Civ Engrs, No. 3952—May, 1912. No. 33161 N.

The Influence of Navigation upon Water Disturbance in Canals and upon the Destruction of Canal Banks (Over den invloed van de scheepvaart op de waterbeweging in kanalen en op de aantasting van den kanaal bodem). P. J. van Voorst Vader, Jr. Discussion upon the destructive action of waves in canals. 2600 w. De Ingenieur—April 14, 1912. No. 32743 D.

Wharves

Light Reinforced Concrete Wharves, Madras, India. F. J. E. Spring. Abridged from Min. of Pro. of Inst. of Civ. Engrs. Illustrates and describes details. 1700 w. Eng News—May 2, 1912. No. 32571.

Public Wharves and Terminals. From a statement of the modern theory of ownership and control of port facilities deduced from leading American authorities by Gen. H. M. Chittenden, in the *Ry & Marine News*. 2000 w. Ry & Engng Rev—May 11, 1912. No. 32825.

MISCELLANY

Australia

Engineering Development of Sydney. G. A. Julius. President's address before the Engng. Assn. of N. S. W., discussing some engineering problems. 2500 w. Aust Min Stand—March 28, 1912. Serial. 1st part. No. 32826 B.

ELECTRICAL ENGINEERING

COMMUNICATION

Oscillograms

A New System of Impact Excitation of Continuous Electrical Oscillations and Their Application to Wireless Telephony. E. Leon Chaffee. A brief study of this new system with notes on its successful application to wireless telephony. Ills. 10,000 w. Jour Fr Inst—May, 1912. No. 33200 D.

Some Interesting Applications of the Oscillograph. H. H. Galleher. Explains its usefulness in testing, designing and timing and other applications. Ills. 1600 w. Elec Jour—May, 1912. No. 33210.

Oscillographic Experiments in Telegraph Relays (Oszillographische Untersuchungen an Telegraphenrelais). J. Zelsko. Experimental studies in telegraphic relay lines and apparatus. Ills. 5600 w. Elektrotech u Maschinenbau—April 28, 1912. No. 32737 D.

Pole Lines

Design of Telephone Pole Lines for Conditions West of the Rocky Mountains.

A. H. Griswold. Describes principally the practice of the Pacific Telephone & Telegraph Co. Ills. 5000 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33235 F.

Radiotelegraphy

Radiotelegraphy with Special Regard to Ship Installations. Director Bredow. Abstract translation of a paper read before the Schiffbautechnische Gesellschaft. Remarks on development and matters relating to ship stations. 3500 w. Engng—May 3, 1912. No. 32885 A.

The Marconi System of Wireless Telegraphy. Outlines the working system. Ills. 1500 w. Elect'n, Lond—April 26, 1912. Serial. 1st part. No. 32833 A.

Rates

Wire Message Rates. William W. Mulford. Brief discussion of the basis for telegraph and telephone rates. 1200 w. Cassier's Mag—May, 1912. No. 33029 B.

Telephony

Telephones on American Railways. Statistics from the report of the Inter-

state Commerce Commission of roads having a telephone mileage of 100 miles or more, with statements relating to their use. 2500 w. Ry Age Gaz—May 24, 1912. No. 33070.

DISTRIBUTION

Circuits

Determination of Load Centers of Circuit. M. C. Rice. An explanation of wiring formulae for computing constructor sizes for circuits. 800 w. Elec Wld—May 18, 1912. No. 32940.

Investigation and Care of Return Railway Circuits. E. E. Nelson. Read before the S.-W. Elec. & Gas Assn. Shows the necessity of first-class track bonding. 3000 w. Can Engr—May 2, 1912. No. 32630.

Current

Prevention of the Theft of Current. George L. Forest. Suggests practical methods of safeguarding. Diagrams. 1000 w. Elec Rev & W Elect'n—May 18, 1912. No. 32952.

Phasing

Phasing Out Polyphase Circuits. Harold W. Brown and S. S. Neu. Gives directions for phasing out. 3000 w. Elec Jour—May, 1912. No. 33211.

Regulators

Some Stages in the Development of Generator Field Regulators. George J. Kirchgasser. Reviews the development of regulating devices. Ills. 2000 w. So Elect'n—May, 1912. No. 32639.

Rural Distribution

The Supply of Energy for Ten Towns from One Station at Greenville, Ohio. D. L. Gaskill. An account of experiences in establishing a large distribution system in a rural district. 2500 w. Elec Wld—May 4, 1912. No. 32614.

Wiring

Conduit Versus Open Wiring for Places Exposed to Dampness or Corrosive Vapors. F. G. Waldenfels. Describes kinds of wiring tried, explaining objections to various types of construction. Ills. 1500 w. Elec Rev & W Elect'n—May 11, 1912. No. 32822.

DYNAMOS AND MOTORS

Braking

The Theory of Dynamic Braking in Industrial Motor Applications. R. H. McLain. Explains the theory and uses of this power absorption and the advantages obtainable. 2000 w. Gen Elec Rev—May, 1912. No. 33005 C.

Electric Braking of Induction Motors. H. C. Specht. Discusses electric braking by alternating current and by direct current, and when each is preferable. 2500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33243 F.

See also Control, under *Dynamos and Motors*.

Commutation

Commutation Curves from Poly-phase Commutator - Motors (Kommutierungs-

kurven bei Mehrphasenkommutator-motoren). Klaudius Schenfer. Calculations and experiments for the determination of such curves. Diagrams. 3200 w. Elektrotech u Maschinenbau—Apr. 28, 1912. No. 32736 D.

The Commutation of D. C. Motors (Die Kommutierung bei Gleichstrom-maschinen). W. Weller. Mathematical discussion with the determination of formulae. Diagrams. 3600 w. Elektrotech u Maschinenbau—Apr. 14, 1912. No. 32735 D.

Commutators

Single-Phase Commutator Motors. R. E. Hellmund and E. W. P. Smith. Discusses the use of commutating poles for the purpose of inducing a voltage equal and opposite to the short circuit voltage. 2500 w. Elec Jour—May, 1912. No. 33209.

Care and Operation of Commutators. W. A. Dick. Outlines some difficulties and indicates how improvements can be made. Ills. 4500 w. Elec Jour—May, 1912. No. 33206.

Starting Conditions of Single-Phase Commutator Motors with Series-Wound Characteristics—Railway Motors (Anlaufverhältnisse der Einphasen-Kommutatormotoren mit Reihenschlusscharakteristik-Bahnmotoren). F. Niethammer and E. Siegel. Mathematical discussion. Serial. 1st part. 7200 w. Elek Kraft u Bahnen—Apr. 14, 1912. No. 32741 D.

Control

The Nature and Extent of Recent Industrial Control Developments. C. D. Knight. Outlines briefly the two principal types of time limit control, and discusses the advance in automatic control. 1500 w. Gen Elec Rev—May, 1912. No. 33001 C.

The Control of Electrically-Driven Rotary Newspaper Presses. Carl F. Scott. Explains the method of operation, and the various steps in the development of the electric drive, and gives an illustrated description of the completely automatic two-motor equipment in such work. 2200 w. Gen Elec Rev—May, 1912. No. 33004 C.

Advantages of Automatic Control in Steel Plant Operation. Stewart C. Coey. Explains the reasons for automatic control as opposed to manual control, and reports tests recently made at Youngstown, in the new developments in automatic control brought about by the use of the series-wound accelerating switch. 2000 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33240 F.

The Selection of Control Apparatus for Steel Plants. M. A. Whiting. Gives a general classification of motor services, and discusses the relative advantages and suitable fields for different equipments. 4000 w. Gen Elec Rev—May, 1912. No. 33002 C.

The Control of Electric Motors on Ships. C. L. Perry. Illustrates and describes some of the equipment used in U. S. naval vessels for controlling motors. 2000 w. Gen Elec Rev—May, 1912. No. 33007 C.

Control for Railway Motors. Describes forms of control apparatus used to start and to regulate the speed of cars. Ills. 2000 w. Ry & Loc Engng—May, 1912, No. 32533 C.

D. C. Motors

Adjustable-Speed Motors. Alexander Dawes DuBois. Discusses the principles, types and characteristics of direct-current motors for industrial service. 4400 w. Elec Wld—May 18, 1912. Serial. 1st part. No. 32938.

Fault Location

Diagnosis of Faults in Electrical Machinery. Remedies to Apply (Diagnostic des Défauts des Machines électriques. Remèdes à appliquer). L. L'Hoest. A review of methods for fault location, and suggestions for various types of machinery. Ills. 8000 w. Soc Belge des Elec—Mar., 1912. No. 32748 E.

Induction Motors

The Commercial Testing of Three-Phase Induction Motors. A. J. Makower and P. A. Mossay. Suggests that a standard method of testing and calculating should be adopted to avoid variations in results. 3000 w. Elect'n, Lond—April 19, 1912. Serial. 1st part. No. 32492 A.

Magnetic Centering

Magnetic Centering of Dynamo-Electric Machinery. Frederick William Carter. Develops methods for calculating the forces resisting axial displacement of the rotating member, and indicates the conditions which favor strong centering. 800 w. Inst of Civ Engrs, No. 3955—May, 1912. No. 33165 N.

Mill Motors

Direct-Current and Alternating-Current Mill Motors for Auxiliary Drives. Brent Wiley. Considers the principal features recommended in the design of a motor for mill and similar work, illustrating and describing types and their proper applications. 3000 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33241 F.

Motors

Some Features of Squirrel-Cage Motor Installation. George J. Kirchgasser. Outlines troubles caused by improper applications. Ills. 3000 w. Elec Rev & W Elect'n—May 25, 1912. No. 33086.

Operation

Operating Notes on Relays, Contactors and Other Basic Automatic Devices. W. C. Yates. Explains the function of some of these devices. Ills. 1800 w. Gen Elec Rev—May, 1912. No. 33006 C.

Turbo-Alternators

Two 3,000-Kilowatt Turbo-Alternators. Drawings and description of turbo-alter-

nators for the Argentine Republic. 600 w. Engr, London—May 10, 1912. No. 32997 A.

Turbo-Generators

Electric Ship Propulsion with Ljungstrom Turbo-Generators. Editorial letter from Berger Ljungstrom giving information concerning their use for electrical transmission. 2500 w. Engng—April 19, 1912. No. 32473 A.

Weight Efficiencies

Weight Efficiency of Electric Motors and of Prime Movers. W. B. Hird. Abstract of paper read before the Newcastle Soc. of Inst. of Elec. Engrs. Compares the weight efficiencies of electric motors and different types of prime movers. 1800 w. Elect'n, Lond—April 19, 1912. No. 32497 A.

Wiring

Induction Motor Wiring. H. B. Foote. Deals with the squirrel-cage type of motor, developing a wiring table. 900 w. Elec Wld—May 25, 1912. No. 33154.

ELECTRO-CHEMISTRY

Cells

See Accumulators, under *Generating Stations*.

Corrosion

Results of the Investigation of the Electrolytic Corrosion of Underground Metallic Structures in Milwaukee. Ray Palmer. Information of the findings and conclusions, with recommendations. 2500 w. Engng & Con—May 1, 1912. No. 32555.

The Mechanism of Corrosion. J. Newton Friend, J. Lloyd Bentley, and Walter West. Read before the Iron & Steel Inst. Gives results of recent experimental study. 2500 w. Mech Engr—May 10, 1912. No. 32980 A.

The Influence of Carbon on the Corrodibility of Iron. C. Chappell. Read before the Iron & Steel Inst. Brief account of investigations and results. 1400 w. Ir & Coal Trds Rev—May 10, 1912. No. 33019 A.

Corrosion of Steel and Its Prevention. Allerton S. Cushman. Read before the Am. Iron & Steel Inst. Gives examples of unusual resistance in wrought iron. Analyses correspond to those of the newer open hearth products. Ills. Also discussion. 4000 w. Ir Age—May 23, 1912. No. 33055 C.

The Corrosion of Nickel, Chromium, and Nickel-Chromium Steels. J. Newton Friend, J. Lloyd Bentley, and Walter West. Read before the Iron & Steel Inst. A study of corrodibility of steel as influenced by alloying elements. 2000 w. Ir & Coal Trds Rev—May 10, 1912. No. 33018 A.

Corrosion Effects in the Steel Superstructure of the Simplon Tunnel (Ueber die Abrostungserscheinungen am eisernen Oberbau im Simplontunnel). Alb. Dänzer-Ischer. Discussion on the occurrence,

the cause and effect of such corrosion, and its probable explanation by the electrolytic theory. Ills. Serial. 1st part. 5500 w. Schweiz Beuzeitung—Apr. 13, 1912. No. 32713 D.

See also Boiler Waters, under MECHANICAL ENGINEERING, *Steam Engineering*.

Electric Furnaces

Experiments on Heat Insulation. F. A. J. FitzGerald. Read before the Am. Elec.-Chem. Soc. Describes preliminary experiments in a study of heat losses in electric furnaces. 1400 w. Can Engr—May 2, 1912. No. 32634.

Improvements in Electric Furnaces and Their Application in the Manufacture of Steel. Hans Nathusius. Read before the Iron & Steel Inst. Remarks on the induction furnace and the arc furnace, giving a detailed description of recent improvements in the latter type. 3500 w. Mech Engr—May 10, 1912. Serial. 1st part. No. 32982 A.

Johnson Continuous Electric Zinc Furnaces. Illustrated description of a furnace for smelting zinc ores. 1500 w. Ir Age—May 2, 1912. No. 32513 C.

See also Electro-Metallurgy, under MINING AND METALLURGY, *Iron and Steel*.

Electrodes

Furnace Electrodes Practically Considered. R. Turnbull. Read before the Am. Elec.-Chem. Soc. Explains the relation of the electrode to the electric furnace, what the electrode is composed of, giving hints as to the best manner of employing electrodes. 2000 w. Can Engr—May 2, 1912. No. 32633.

Electrolysis

Electricity Applied to Chemistry. Harry C. Jones. Discusses the electrolysis of acids, bases and salts, and the possibilities of electrolytic separations. 4000 w. Eng & Min Jour—May 25, 1912. No. 33083.

Electricity and Chemical Action. Harry C. Jones. Explanation of the primary and secondary cell, the conversion of electrical into intrinsic energy, etc. 6500 w. Eng & Min Jour—May 18, 1912. No. 32944.

Induction Furnaces

The Action of Electro-Mechanical Forces on the Bath of Induction Furnaces. Magnus Unger. Analysis of the "pinch effect," the "centrifugal effect," and the combined effect. Diagrams. 2000 w. Met & Chem Engng—May, 1912. No. 32644 C.

Nitrogen

The Fixation of Atmospheric Nitrogen for the Formation of Aluminum Nitride (La Fixation de l'Azote Atmosphérique par l'Emploi des Nitrures d'Aluminium). Francis Marre. The use and history of this preparation in agriculture, and chemical description of methods for derivation. 3500 w. Génie Civil—May 11, 1912. No. 32784 D.

Ozone

Ozone: Its Properties and Commercial Production. Milton W. Franklin. Considers the production of ozone, ozone generators, forms of ozonators, etc. 3500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33244 F.

ELECTRO-PHYSICS

Alternating Currents

On Wave-Form Sifters for Alternating Currents. Albert Campbell. Abstract of paper before the Phys. Soc. Explains the wave form sifter and some of its applications. 800 w. Elect'n, Lond—April 19, 1912. No. 32494 A.

Conductors

The Characteristics of Copper and Aluminum Overhead Line Conductors. E. V. Pannell. Gives a few rules by the use of which a comparison of line conductors may be made and deductions applying to British conditions. 1800 w. Elec Rev, Lond—May 10, 1912. Serial. 1st part. No. 32972.

Currents

The Rotating Electric-Current Field. A. E. Kennelly. Abstract of paper read at Turin, Italy. Discusses new quantitative relations bearing on Ferraris' rotating vector theory in relation to electric current flow in two dimensions. 2500 w. Elect'n, Lond—April 19, 1912. No. 32495 A.

Evaporation

The Evaporative Capacity of Lead-Lined Copper Coils. B. Viola. A record of three runs from evaporation practice with some general practical conclusions on evaporation. Charts. 1500 w. Met & Chem Engng—May, 1912. No. 32646 C.

Harmonic Analysis

The Best Form of the Resonance Method of Harmonic Analysis. R. Beattie. Examines the errors to which the resonance method is liable and describes a process for correcting these errors. 3500 w. Elect'n, Lond—April 19, 1912. No. 32498 A.

Oscillations

A New Method of Impact Excitation of Undamped Oscillations. E. L. Chaffee. From Pro. Am. Acad. of Arts and Sciences. Discusses the general characteristics of a new oscillation gap, studying the oscillations in detail, and giving applications. Ills. 2500 w. Elect'n, Lond—April 26, 1912. No. 32830 A.

Radium

The Distribution of the Active Deposit of Radium in an Electric Field. E. M. Wellisch and H. L. Bronson. Gives results of a series of experiments undertaken to study the distribution of activity on the electrodes and how it was affected in an electric field. 6000 w. Am Jour of Sci—May, 1912. No. 33095 D.

Vectors

A Study of Polyphase Relations by Kirchhoff's Laws. B. C. Dennison. Gives

a solution of various problems, giving the vector relations for each case. 2000 w. So Elect'n—May, 1912. No. 32638.

Voltage Impulses

Propagation of Impulses Over a Transmission Line. J. H. Cunningham and C. M. Davis. Report of investigations. Ills. 2500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33247 F.

GENERATING STATIONS

Accumulators

Regeneration of Sulphated Storage Cells. Dale S. Cole and C. W. Bennett. An account of cells tested and treated by the method outlined by G. A. Perley in a recent article. 1500 w. Sib Jour of Engng—May, 1912. No. 33204 C.

Central Stations

Largest Central Station in the State of Kansas. Illustrated description of a modern turbine generating plant of 8,000 kw. rating, at Wichita, Kan. Also editorial note. 2500 w. Elec Wld—May 25, 1912. No. 33152.

Hydro-Electric

Plant Efficiency. J. D. Ross. An analysis of the losses of a hydro-electric system at Seattle. 2500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33234 F.

Power Plant for Upper Michigan Mines. Illustrated description of a high-head hydro-electric development on the Marquette Range, using three types of pipe line. 1800 w. Ir Age—May 2, 1912. No. 32512 C.

New Hydro-Electric Plant of the Shawinigan Water & Power Co. Julien C. Smith and F. T. Kallin. Illustrates and describes a development at Shawinigan Falls, Quebec, capable of generating electricity up to 100,000 h. p. 3500 w. Elec Wld—May 4, 1912. No. 32612.

The Pacific Gas and Electric Co. A. R. Maujer. Illustrated description of a development comprising 12 hydro-electric stations and 3 steam plants, having a generating capacity of over 131,000 kw. 2500 w. Power—May 21, 1912. No. 32959.

The Swedish State Power Stations. Illustrates and describes the Porjus Falls State hydro-electric power station and matters related. 1600 w. Engng—May 3, 1912. No. 32883 A.

The Rjukanfos Water Power Plant (Wasserkraftanlage am Rjukanfos). F. Marguerre. Details of the construction and machinery in the plant operated at the foot of a 570 meter water-falls. Ills. Serial. 1st part. 6800 w. Elek Kraft u Bahnen—April 24, 1912. No. 32742 D.

The Hydro-Electric Plant at Eymoutiers, Haute-Vienne (L'Installation Hydro-électrique d'Eymoutiers, Haute-Vienne). Description of dam, head-works, and plant equipment. Ills. and plate. 2500 w. Tech Mod—April 15, 1912. No. 32767 D.

See also New Zealand, under *Generating Stations*.

Mine Power

Does It Pay the Average Coal Mine to Purchase Central Station Power? Graham Bright. Gives information and reasons for proving the advisability of a mine's purchasing rather than generating its own power. 3000 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33238 F.

New Zealand

Large Hydroelectric Developments of the New Zealand Government. Brief account of the Lake Coleridge installation to furnish energy for railway service, towing of canal-boats, street lighting and various industrial purposes. 2000 w. Elec Wld—May 11, 1912. No. 32803.

Operation

Operating Records of a Small Plant. O. Monnett. Actual figures from a plant serving a group of buildings with light, heat, power, hot water, etc. Ills. 1200 w. Power—May 28, 1912. No. 33156.

Power Stations

Notes on Power Station Working. J. W. Jackson. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Reviews recent advances on the mechanical side. 1200 w. Elect'n, Lond—April 19, 1912. No. 32493 A.

Rates

The Effect of Central Station Rates on New Business. H. S. Sines. Discusses the "cost to serve" system of charging and its applications. 2200 w. Elec Rev & W Elect'n—May 4, 1912. No. 32602.

Power Requirements from Central Stations (Betriebsergebnisse elektrischer Zentralen). Adolf Ludin. Illustrating from various load diagrams the irregularity in the demand for electric power on service lines. Serial. 1st part. 1700 w. Elektrotech u Maschinenbau—April 14, 1912. No. 32734 D.

Switchboards

Removable-Panel Switchboard and Instrument Columns. Warren H. Miller. Illustrated description of switchboards designed for facilitating repair work and of individual generator and motor switch columns. 1700 w. Elec Wld—May 4, 1912. No. 32613.

The Application of Automatic Selecting Devices to Telephone Multiple Switchboards. Alfred H. Dyson. Discusses means and results obtained by the application of selective switches to common battery multiple telephone switchboard systems. 4500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33233 F.

LIGHTING

Arcs

Yellow Flame Arcs. M. Solomon. Abstract of a paper before the Birmingham Sec. of the I. E. E. Deals with the characteristics of the arcs in typical types and the effect of changes of current and voltage and of different carbons on the light distribution curves. 4000 w. Elect'n, Lond—May 3, 1912. No. 32873 A.

Illumination

Lighting of the Underground Railways of London. From a paper by Haydn T. Harrison, read before the Ill. Engng. Soc. Illustrates and describes methods employed. 1200 w. Elec Wld—May 11, 1912. No. 32805.

Private House Lighting by Electricity. W. R. Rawlins. Abstract of paper read before the Ill. Engng. Soc. Suggestions for various classes of houses, explaining the principles and some difficulties. 1500 w. Elect'n, Lond—April 26, 1912. No. 32831 A.

Incandescent Lamps

The Latest Incandescent Lamp. Evan J. Edwards. Detailed discussion of factors concerned in the making of incandescent lamps, the processes involved in the manufacture and testing and the general properties of the finished product. Ills. 5500 w. Jour Assn of Engng Socs—April, 1912. No. 33113 C.

Incandescent Lamps with Luminous Points (Lampes a incandescence a source ponctuelle). A. Bidault des Chaumes. Reviews the operation of luminous pointed lamps for use in stereopticons, etc. Ills. 3700 w. Génie Civil—May 18, 1912. No. 32786 D.

Mercury-Vapor Tubes

The Moore Lighting System (Ueber Moore-Lichtanlagen). W. Grix. Description of the operation and results from the Moore mercury-vapor tube system of lighting. Ills. 4400 w. Zeitschr des Ver deutscher Ing—April 13, 1912. No. 32719 D.

Street Lighting

Arc vs. Tungsten Street-Lighting in Small Towns. C. E. Stephens. Discusses the requirements of street illumination and the conditions, quality and quantity of light and its relation to intensity, showing that local conditions determine the unit to be used. 4500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33237 F.

MEASUREMENT**Magnesium**

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Meters

Some Considerations of Detail in the Design of Electricity Meters. Discusses details that are an annoyance to repairers and testers. 2500 w. Elec Rev, Lond—May 10, 1912. No. 32971.

Electrical Meters on Variable Loads. David Robertson. Deals both theoretically and experimentally with the behavior of electricity meters on variable loads. Describes experiments. 6500 w. Inst of Elec Engrs—May, 1912. No. 32973 N.

Meter Practice for Small Central Stations. Guy R. Grove. Suggestions for the testing of meters and remarks on their importance. 2500 w. Elec Rev & W Elect'n—May 25, 1912. No. 33087.

The Use of Meters in Railway Carriages (De l'Emploi des Compteurs sur les Voitures de Tramways). M. Delthil. Types of electrical meters adapted for use, and results obtained by their use. Discussion. Ills. and plates. 1600 w. Soc Belge des Elec—Feb., 1912. No. 32749 E.

Recorder

Human Accuracy: Multi-Recorder for Lighting Phenomena and Switching. E. E. F. Creighton, H. E. Nichols, and P. E. Hosegood. Describes a new instrument which will record the time to the second of a phenomenon of any kind that can be made to close an electrical contact. Describes the manner of operation. Ills. 8500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33246 F.

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Stresses

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Testing

Instrument Testing Methods and Equipment for Central Stations. E. P. Peck. Describes methods of checking watt-hour meters and testing polyphase watt-hour meters. Ills. 2500 w. So Elect'n—May, 1912. No. 32637.

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High-Speed Electrical Machinery. F. H. Clough. Abstract of a paper read

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Homogeneous Insulations for Simple Electrical Conductors (*Sur les Revêtements Isolants Homogènes pour Conducteurs Électriques Simples*). M. Michard. Mathematical study. Discussion. Diagrams. 3200 w. *Bul Soc Int d'Électriciens*—April, 1912. No. 32753 F.

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INDUSTRIAL ECONOMY

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See also Labor, under INDUSTRIAL ECONOMY; and Accident Prevention, and Safety Devices, under MECHANICAL ENGINEERING, *Machine Works and Foundries*.

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Recent Advances in the Art of Battleship Design. D. W. Taylor. Discusses modern battleships from the characteristics of offensive power, speed and endurance and defensive power. 7500 w. Jour Fr Inst—May, 1912. No. 33201 D.

Battleship Florida, the Latest United States Dreadnought. Henderson B. Gregory. Illustrated detailed description of the vessel and its equipment, with report of trial. 5000 w. Int Marine Engng—May, 1912. No. 32598 C.

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On the Measurement and Automatic Recording of Dead Reckoning. F. R. S. Bircham. Read before the Inst. of Nav. Archts. Reviews previous inventions of this kind, explains the requirements, and describes the instrument. Ills. 6500 w. Engng—April 19, 1912. No. 32475 A.

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Wilson. Describes 20 h.p. engines of vessels for service in the Antarctic. Ills. 1200 w. Marine Rev—May, 1912. No. 32817 C.

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The Economy of the Diesel-Engined Ship (Die Wirtschaftlichkeit der Diesel-Motorschiffe). Richard Colell. Comparative review of the cost of driving vessels by Diesel engines and ordinary steam engines. 5600 w. Schiffbau—April 24, 1912. No. 32726 D.

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The 700-Ton Turbine-Driven French Destroyer "Bouclier." Brief description and report of trials. 500 w. Engng—April 19, 1912. No. 32470 A.

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Shell Suction Dredger Used in the Dutch Shell Lime Industry. F. Muller von Brakel. Detailed description, with elevation and plan. 1500 w. Int Marine Engng—May, 1912. No. 32593 C.

The Danish Suction Dredge Graadyb. Axel Holm. Illustrated description of a recently built 900-ton suction hopper dredge. 1500 w. Int Marine Engng—May, 1912. No. 32596 C.

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Opening of the Naval Drydock, New York. Illustrates and describes methods used in constructing an unusually difficult engineering work. 2500 w. Sci Am—May 25, 1912. No. 33046.

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Ferries

Vehicular Ferries in New South Wales. Henry Harvey Dare. Describes the self-propelled ferries, the hand-gearred ferries on wire ropes, and the power-driven national ferries. Ills. 2200 w. Inst of Civ Engrs, No. 3958—May, 1912. No. 33163 N.

Iceberg Detection

Detecting the Proximity of Icebergs. Illustrated description of the Barnes resistance thermometer, as given in the patent. 2000 w. Elec Rev & W Elect'n—May 11, 1912. No. 32823.

Lightships

The Effect of Bilge-Keels on the Rolling of Lightships. Part I. George Idle. Part II. G. S. Baker. Read before the Inst. of Nav. Archts. Detailed report of experimental investigations. 6000 w. Engng—April 19, 1912. No. 32474 A.

Marine Engines

A Commercial Type Marine Motor. Illustrated description of the "Djinn" engines, built at Bristol, Eng. 5000 w. Engr, Lond—May 10, 1912. No. 32993 A.

Marine Motor. Notes on an engine built at Dartmouth, Eng., showing that it embodies ideal requirements set forth two years ago. Ills. 4000 w. Engr, Lond—May 3, 1912. No. 32890 A.

Marine Safety

Safeguarding Life and Property at Sea. George A. Soper. Constructive suggestions for an international marine conference. 2500 w. Engineering Magazine—June, 1912. No. 33134 B.

Motor Boats

The A. D. A. C. Prize Competition for a 1,000 Mark Motor-Boat (Das A. D. A. C.-Preisausschreiben für ein 1,000 Mark-Motor-Boot). H. Méville. Description of some of the designs submitted, and the three winning designs. Diagrams. 1800 w. Zeit d Mitt Motorwagen Ver—April 15, 1912. No. 32727 D.

Oil Engines

A High-Power Oil Engine for Tugboat Service. Illustrated description of a 300 h.p. 4-cylinder oil engine for the experimental tugboat "Schlepp." 1200 w. Sci Am Sup—May 11, 1912. No. 32670.

See also Diesel Engines, under MARINE AND NAVAL ENGINEERING.

Propulsion

Screw Propulsion (L'Hélice Propulsive). P. Lorain. Historical review and mathematical notes on design of screw propellers. Ills. 4500 w. Rev Gén des Sciences—April 15, 1912. No. 32766 D.

See also U. S. Navy, under MARINE AND NAVAL ENGINEERING, and Turbo-Generators, under ELECTRICAL ENGINEERING, *Dynamos and Motors*.

Safety Pontoons

Safety Pontoons for Ocean Vessels. Henry R. Towne. Suggestions for converting the deck-houses into water-tight pontoons which would be left floating and give refuge to the passengers and crew.

Short editorial. 2200 w. Eng News—May 2, 1912. No. 32570.

Salvage

The Salvage of the San Giorgio. An illustrated account of the accident to this vessel, Aug. 12, 1911, the salvage, repairing, and rearming of this cruiser. 3500 w. Engr, Lond—April 19, 1912. Serial. 1st part. No. 32461 A.

The Salvage of Submarines (Essais de Relevage des Sous-Marins). Andre Dachs. Suggestions for attaching deflated balloons to the sunken vessel, inflating them until vessel rises, when it may be towed to port. Ills. 2200 w. La Nature—May 4, 1912. No. 32759 D.

Raising and Sinking the "Maine" (Le Renflouement et l'Immersion du Cuirassé "Maine"). E. Lignorelles. Details in the construction of the coffer-dam, the method of floating the vessel, and subsequent sinking. Ills. 3700 w. Génie Civil—May 4, 1912. No. 32782 D.

Ship Designs

The "Unsinkable" Ship. J. Bernard Walker. Gives cross-sectional views of three famous ships, and discusses improvements that should be introduced into future merchant ships. 2000 w. Sci Am—May 11, 1912. No. 32668.

Shipyards

The Newport News Shipyard. Waldon Fawcett. Illustrates and describes details of this industrial plant. 2500 w. Mfrs' Rec—May 2, 1912. No. 32534.

Speed Recorder

Speed Recording. Illustration, with description of the new type speed recorders for use on two new Argentine battleships. 1000 w. Engr, Lond—May 3, 1912. No. 32895 A.

Steamships

The Strength of Large Ships. A letter from Reginald Ryves discussing the effect of size on the strength. 2500 w. Engr, Lond—May 3, 1912. No. 32894 A.

Stern Frame and Brackets of the Cunard Liner Aquitania. Illustrates and describes these large castings for a new steamship. 1000 w. Engr, Lond—May 3, 1912. No. 32892 A.

French Liner France. Illustrated description of the largest and speediest of the French merchant vessels yet constructed. 1800 w. Engr, Lond—April 26, 1912. No. 32852 A.

The Transatlantic Steamer "France" (Le Transatlantique "France"). A. Troller. Brief description of this new vessel on the Compagnie Générale Transatlantique line; the largest and fastest French steamer. Ills. 1800 w. La Nature—April 27, 1912. No. 32758 D.

The Transatlantic Steamer "France" (Le Paquebot Transatlantique "France"). Detailed description of this largest French steamship, completed and launched in 1912. Ills. Serial. 1st part. 3600 w. Tech Mod—May 15, 1912. No. 32771 D.

The Steamship "France," of the Compagnie Générale Transatlantique (Le Paquebot "France," de la Compagnie Générale Transatlantique). M. Gouriet. Details in the construction and equipment of this liner. Ills. and plate. 8800 w. Génie Civil—April 20, 1912. No. 32776 D.

The Electrical and Mechanical Appliances on the SS. "Rotterdam" of the Holland-America Line and Various Electric-Driven Coal and Freight Transports (De elektrische en mechanische inrichtingen van het s.s. "Rotterdam" der Holland-Amerikaalijn en de verschillende electrisch gedreven steenkolen- en goederentransport-inrichtingen). H. Van Helden. Describes electrical appliances on board. Ills. and plates. 4500 w. De Ingenieur—April 20, 1912. No. 32744 D.

Steam Turbines

The Tosi Steam-Turbines. Illustrates and describes turbines recently constructed for ship propulsion and for the driving of electric generators. Plate. 3500 w. Engng—April 26, 1912. No. 32843 A.

Submarine Mines

Automatic Submarine Mines. Explains conditions to be fulfilled and gives illustrated detailed description of Elia's automatic submarine mines (Vickers-Brequet system). Plate. 7500 w. Engng—April 19, 1912. Serial. 1st part. No. 32468 A.

Submarines

The Use of Electricity in Submarines (L'application de l'électricité aux bateaux sous-marins). A. Bezzi. Report presented to the International Congress of Applied Electricity. Serial. 1st part. 2400 w. L'Électricien—April 13, 1912. No. 32765 D.

Titanic

Sea-Borne Traffic and the Titanic Disaster. Richmond Pearson Hobson. A

measure of actual dangers and effective remedies which may readily be applied. 6000 w. Engineering Magazine—June, 1912. No. 33125 B.

Foundering of the Titanic. An account of the disaster with drawings of the ship. 1500 w. Int Marine Engng—May, 1912. No. 32599 C.

Lessons of the "Titanic" Disaster. Henry Harrison Supplee. Discusses methods for increasing safety at sea. 2500 w. Cassier's Mag—May, 1912. No. 33030 B.

The Loss of the Titanic. Prof. J. H. Biles. Also editorial. Discusses the disposition of bulkheads and the effect on safety. Ills. 5000 w. Engr, Lond—April 19, 1912. No. 32465 A.

The Structure of the "Titanic." Gives drawings showing the sectional elevation, deck plans, and cross-section of this steamer, with particulars. Plate. 2500 w. Eng News—May 9, 1912. No. 32683.

The "Titanic" Disaster. Editorial on the disaster of April 15. 2200 w. Engng—April 15, 1912. No. 32471 A.

See also Hudson Bay Project, under RAILWAY ENGINEERING, *New Projects*.

U. S. Navy

Propulsive Machinery and Oil Fuel in the United States Naval Service. C. W. Dyson. Reviews recent improvements in the naval service, and gives valuable information relating to naval engineering development. General discussion by Rear Admiral Melville and others. Ills. 14000 w. Pro Engrs Club of Phila—April, 1912. No. 33117 D.

The United States Navy Department and "Engineering." Editorial on a recent report of the U. S. Joint Army and Navy Powder Board. 3000 w. Engng—April 26, 1912. No. 32845 A.

MECHANICAL ENGINEERING

AERONAUTICS

Aerodynamics

The New Eiffel Aerodynamic Laboratory at Auteuil. Illustrated description of the plant with results obtained by Gustave Eiffel. 2000 w. Sci Am—May 18, 1912. No. 32947.

Aerography

Laws of the Air Tides, Currents, Streams and Flows of the Globe (Régimes des Marées, Courants, Fleuves et Flux Aériens du Globe). Maurice Dibos. An aerographic study of the monthly currents. Plate. 20800 w. Mem Soc Ing Civ de France—Feb., 1912. No. 32752 G.

Air Resistance

Analogous Laws in Frictional Reactance (Das Aehnlichkeitsgesetz bei Reibungsvorgängen). H. Blasius. Comparative studies in the resistance of rape-seed oil, water and air, with determinations there-

from. Diagrams. 3500 w. Zeitschr des Ver deutscher Ing—April 20, 1912. No. 32723 D.

Aviation

Aerial Flight. Henry Reginald Arnulph Mallock. James Forrest. Lecture delivered at the Inst. of Civ. Engrs., April 19, 1912. An examination of the principles involved and of the present condition of the art. 4500 w. Engng—April 26, 1912. No. 32846 A.

Control

The Efficiency of Control Systems in Flying Machines. Abstract of a paper by Albert A. Merrill read at the Boston meeting. Discusses the three important points. 1200 w. Jour Am Soc of Mech Engrs—May, 1912. No. 33214 D.

Design

Aeroplane Construction as Shown at the Paris Aero Salon. Horace B. Wild. Il-

illustrates and describes mechanical and structural features of the latest air craft. 6000 w. Engineering Magazine—June, 1912. No. 33132 B.

Design of Racing Aeroplanes. Stanley Yale Beach. Drawings and description of fast monoplanes, with designs for an international cup defender. 1500 w. Sci Am—May 4, 1912. No. 32577.

Some New German Aeroplanes and Motors. (Einige neuere deutsche Flugzeuge und Flugmotoren). Franz Klee. Description of some of the leading German types. Ills. and plate. 1800 w. Motorwagen—April 10, 1912. No. 32730 D.

Recent Developments in Air Ships, Aeroplanes, and Motors in France (Die neuere Entwicklung der Luftschiffe, Flugmaschinen und Luftfahrzeug-motoren in Frankreich). F. Bendemann. Illustrated review of the latest tendencies in design as brought forth in the Paris Exhibition. Serial. 1st part. 6000 w. Zeitschr des Ver deutscher Ing—April 20, 1912. No. 32721 D.

Engines

The Alexander Prize for Aeroplane Engines. Brief report of the engines tried. 1500 w. Engng—April 19, 1912. No. 32472 A.

American Aeronautic Motors. Stanley Yale Beach. Illustrates and describes some of the new aviation engines made in the United States. 2000 w. Sci Am Sup—May 18, 1912. No. 32949.

Exhibitions

The New York Aero Show. Stanley Yale Beach. Illustrates some novel American aeroplanes exhibited. 2500 w. Sci Am—May 25, 1912. No. 33045.

The General Air-Craft Exhibition in Berlin, April 3-14, 1912 (Allgemeine Luftfahrzeug-Ausstellung, Berlin 3-14. April, 1912). Description of some of the leading dirigibles and aeroplanes exhibited. Serial. 1st part. 2700 w. Motorwagen—April 10, 1912. No. 32728 D.

Military

Naval and Military Aviation. Summary of a memorandum issued by the British War Office, presenting features of interest to engineers. 1800 w. Engr, Lond—April 19, 1912. No. 32463 A.

Monoplanes

The Aviatik Monoplane (Der Aviatik-Eindecker). Leopold Szkolnik. Brief description of this make. Ills. and plates. 1000 w. Der Motorwagen—April 10, 1912. No. 32729 D.

AUTOMOBILES

Axles

Making an Axle. Illustrates and describes construction details from the bar stock to the finished work. 3500 w. Automobile—May 23, 1912. No. 33063.

Austin

The New 10 h.p. Austin. Illustrated description of a new 4-cylinder car. 1000 w. Autocar—April 20, 1912. No. 32507 A.

Cams

A Critical Analysis of Automobile Cams. H. Leland Lowe. Explains the development of a cam outline giving an harmonic motion to the valve, similar to the motion of an engine piston. 3000 w. Horseless Age—May 15, 1912. No. 32914.

Engines

The Castiglione and Bolton Engine. Illustrated description of an engine with a longitudinal rotary distributor above the cylinder heads. 1000 w. Autocar—April 20, 1912. No. 32506 A.

The "Low Engine." A. M. Low. Describes a remarkable light-weight petrol motor for cars and aeroplanes. 2000 w. Auto Jour—April 20 1912. No. 32504 A.

Fuels

Use of Paraffin as Fuel. An account of experiments with this substitute for gasoline, and some of the difficulties encountered. 1500 w. Automobile—May 2, 1912. No. 32550.

Garage Lighting

Illuminating the Private Garage. C. E. Palmer. Suggestions for electric wiring arrangements and equipments. Ills. 1200 w. Horseless Age—May 1, 1912. No. 32626 C.

Garages

Private Garage Equipment and Arrangement. B. F. Geyer. Considers the essentials and requirements of the garage owner who cares for his own car. 1700 w. Horseless Age—May 1, 1912. No. 32625 C.

Planning and Outfitting a Small Country Garage. Discusses the layout of plant, necessary equipment and cost. Ills. 2500 w. Automobile—May 16, 1912. No. 32933.

System in a Private Southern Garage. Detailed description of the garage of E. F. Sims of Houston, Tex. Ills. 1500 w. Horseless Age—May 1, 1912. No. 32628 C.

Alamo Garage and Salesroom, San Antonio. Illustrations, with description of facilities and equipment. 1500 w. Horseless Age—May 1, 1912. No. 32621 C.

A Well Systematized Public Garage on Chicago's Boulevard System. Illustrated description of the People's Garage and Livery Co.'s building and its equipment. 1600 w. Horseless Age—May 1, 1912. No. 32617 C.

Bridgeport's Blue Ribbon Garage. Illustrated description of a well equipped garage. 1500 w. Horseless Age—May 1, 1912. No. 32169 C.

Broad-Oak Garage at Columbus, O. Illustrated description of an up-to-date garage and its management. 2000 w. Horseless Age—May 1, 1912. No. 32623 C.

Complete Establishment of the Britton Company in Hartford. Illustrated description of large automobile works, carrying on all branches of the automobile business excepting the assembling of a complete machine. 1800 w. Horseless Age—May 1, 1912. No. 32620 C.

Houston's Storage and Service Garage. Illustrated description of the Sweeney garage in Houston, Texas. 2000 w. Horseless age—May 1, 1912. No. 32622 C.

The Clinton Garage. Illustrated description of a public garage near the Brooklyn Bridge. 800 w. Horseless Age—May 1, 1912. No. 32618 C.

Warner Garage, Bridgeport, Conn. Illustrated description of a private garage and its equipment. 900 w. Horseless Age—May 1, 1912. No. 32627 C.

Garage Work

Home-Made Foundry Equipment for Garage Work. S. M. Howell. Illustrated suggestions for isolated places far from foundries. 1500 w. Horseless Age—May 1, 1912. No. 32624 C.

Gear Shifts

New Automatic Gear-Shifting Device. Illustrated description of a device for shifting gears by the clutch spring, controlled from quadrant. 1800 w. Automobile—May 16, 1912. No. 32934.

Henderson

Henderson Here. Illustrates and describes interesting details of two models of this new car. 1500 w. Automobile—May 23, 1912. No. 33064.

Hydraulic Drive

Hydraulic Drive for Motor Cars (Hydraulischer Antrieb für Motorwagen). A. Heller. Description of the Lentz Drive. Essentially a replacement of the ordinary differential and transmission gears with a hydraulic motor. Ills. 3300 w. Zeitschr des Ver deutscher Ing—April 13, 1912. No. 32718 D.

The Hugo Lentz Hydraulic Drive for Motor Cars (Das hydraulische Getriebe für Motorwagen von Hugo Lentz). A. Heller. Details in the arrangement of motor and drive for this new type. Ills. and plate. 4500 w. Motorwagen—April 20, 1912. No. 32731 D.

Keeton

Keeton Announces Six and Four for 1913 Line. Details of new 6-cylinder and 4-cylinder models are illustrated and described. 2500 w. Automobile—May 16, 1912. No. 32935.

Keeton Car Embodies New Features. Illustrates and describes features of recent models. 1200 w. Horseless Age—May 8, 1912. No. 32671.

Lighting

Dynamo Requirements for Electric Lights. Leonard Kebler. Read before the Soc. of Auto. Engrs. Considers voltage model for lamps of the desired capacity and for different types of motor designs. 2500 w. Automobile—May 2, 1912. Serial. 1st part. No. 32553.

Lubrication

Lubricating Systems. Review of the methods of maintaining the oil feed to the engine bearings. 4500 w. Autocar—April 20, 1912. Serial. 1st part. No. 32505 A.

Military

The Program for the Endurance Test of Heavy Weight Military Cars in 1912 (Le Programme de l'Epreuve d'Endurance des "Poids Lourds" Militaires, en 1912). D. Renaud. Specifications for test weights and equipment. Ills. 3000 w. Génie Civil—May 4, 1912. No. 32781 D.

Motor Trains

The German Military Motor Truck Bonus System. Dr. Ernst Valentine. Illustrates and describes the motor trains of Germany and explains the system that has helped their development. 1800 w. Horseless Age—May 15, 1912. No. 32913.

Motor Vehicles

Results of Motor Vehicles Research at Massachusetts Institute of Technology. Information concerning this investigation, with tabulated data obtained. 1500 w. Elec Wld—May 18, 1912. No. 32939.

National

Series V National. Illustrates and describes constructional changes in this new model. 2500 w. Automobile—May 2, 1912. No. 32552.

Omnibus

The Macfarlane and Burge Electric Omnibus System (Omnibus électrique système Macfarlane et Burge). F. Marion. Presents the chief advantages of their system of traffic transportation. Ills. 3200 w. Rev Indus—April 20, 1912. No. 32772 D.

Power

The Automobile as a Portable Source of Power. Illustrates and describes Auxiliary uses for the motor vehicle engine. 1500 w. Sci Am—May 18, 1912. No. 32948.

Rims

Captain Detachable Rims. Illustrates and describes particulars of the various types, including the new twin rim and the divisible rim. 800 w. Autocar—May 11, 1912. No. 32970 A.

Rover

The New 12 h. p. Four-Cylinder Rover. A description of the chassis and report of the running. Ills. 2500 w. Autocar—May 4, 1912. No. 32871 A.

Running Expenses

Economizing on a Car's Running Expenses. Calls attention to neglected points and their effects. Ills. 3500 w. Automobile—May 9, 1912. No. 32680.

Sava

The 18 h. p. Sava Car. Illustrated detailed description. 1200 w. Autocar—April 27, 1912. No. 32827 A.

Scavenger Trucks

See Refuse, under CIVIL ENGINEERING, *Municipal*.

Sleighs

Automobile Sleighs (Traineau-Automobile). René Le Grain. A study of the automobile as applied to work in winter over snowy routes, and some devices for

their propulsion. Ills. 5000 w. *Bul Soc d'Encour*—April, 1912. No. 32746 E + F. **Star**

The 20-h. p. Star Car. Brief illustrated description of a moderately priced 6-cylinder car. 800 w. *Auto Jour*—May 11, 1912. No. 32969 A.

Tires

Tires: Their Use and Abuse. First of a series of articles giving practical hints as to the ways of getting the best results from tire equipment. 1200 w. *Automobile*—May 2, 1912. Serial. 1st part. No. 32551.

Tractors

The General Agricultural Exhibit at Paris (Le Concours Général Agricole de Paris). G. Coupan. Illustrated review of some of the farm tractors at the exhibit in February. Serial. 2nd part. 3200 w. *Génie Civil*—April 13, 1912. No. 32775 D.

Trucks

Hauling Structural Steel with Motor Trucks. Illustrated description of a truck with special body for carrying long beams. 1800 w. *Ir Trd Rev*—April 18, 1912. No. 32202.

Wheels

Wire Wheel Again Comes to the Front. Illustrates and describes the mode of manufacture. 1600 w. *Automobile*—May 16, 1912. No. 32932.

COMBUSTION MOTORS

Diesel Engines

Notes on Maintenance of the Diesel Engine. Considers some difficulties and their remedies, and things of importance for their successful working. 1500 w. *Elec Rev, Lond*—April 19, 1912. No. 32503 A.

See also same heading, under MARINE AND NAVAL ENGINEERING.

Engine Building

Metallurgy for the Engine Builder. Seth G. Malby. Brief study of metals, their manufacture, heat treatment, composition, etc., with remarks on corrosion. Ills. 5000 w. *Rudder*—May, 1912. No. 32678 C.

Engine Design

Engine Design Suggestions. Peter Jenness. Discusses the question of valve timing. 3000 w. *Rudder*—May, 1912. No. 32679 C.

Engines

See same heading, under *Aeronautics and Automobiles*.

Gas Producers

A Paraffin Gas Producer. Illustrated description of an arrangement to supply paraffin in a form suitable for fuel of an internal combustion engine. 1000 w. *Autocar*—April 20, 1912. No. 32508 A.

See also Peat Power, under *Combustion Motors*.

Ignition

Electric Ignition in Internal Combustion Engines. John S. Leese. Discusses the respective claims of the high

and low tension systems. 1200 w. *Elec Rev, Lond*—April 19, 1912. No. 32500 A.

Internal-Combustion Engines

The Thermal Efficiency of Internal-Combustion Engines. Dugald Clerk. From report of British Science Guild on "National Sources of Energy." Considers that it may be taken as twice as efficient as the steam engine. 1800 w. *Mech Engr*—April 19, 1912. No. 32488 A.

Internal Combustion Engines for Electrical Installations. Illustrates and describes types. 12000 w. *Elec Rev, Lond*—April 19, 1912. No. 32502 A.

Theories on Internal Combustion Engines (Théorie des Moteurs à Combustion Interne). Leon Letombe. Especially considering engines of the Diesel type. Diagrams. Serial. 1st part. 4200 w. *Tech Mod*—May 1, 1912. No. 32769 D.

Oil Engines

Oil Engines for Central Station Prime Movers. From a paper by Earle D. Jackson, read before the Minn. Elec. Assn. A summary of types, properties and qualifications of available engines. 2000 w. *Elec Wld*—May 4, 1912. No. 32615.

See also Diesel Engines, under *Combustion Motors*; and Diesel Engines and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Paraffin

See Gas Producers, under *Combustion Motors*; and FUELS, under *Automobiles*.

Peat Power

The Peat Producer Gas Power Plant at the Government Fuel-Testing Station. B. F. Haanel. From the *Jour. of Can. Peat Soc*. Treats of the production of power from peat as shown by investigations made at the Fuel Testing Station. Ills. 2500 w. *Can Engr*—May 2, 1912. No. 32631.

HEATING AND COOLING

Air Conditioning

Temperature and Humidity. Dr. W. A. Evans. Address before the Midland Club. Reviews early investigations on air qualities and effects of humidity on the body. 2500 w. *Met Work*—May 3, 1912. Serial. 1st part. No. 32535.

Cold Storage

The Preservation of Fresh Eggs by the Lescarde System of Sterilization and Refrigeration (La Conservation des Oeufs Frais par Stérilisation et Réfrigération, Système Lescardé). Henri Blin. Description of the method of treatment by this system. Ills. 3200 w. *Génie Civil*—May 4, 1912. No. 32780 D.

Factories

Heating and Ventilation of New Bosch Factory. Illustrates and describes the heating and ventilating arrangement for this new factory in Springfield, Mass. 1500 w. *Power*—May 28, 1912. No. 33158.

Heating Large Concrete Factory Buildings. Describes the heating and ven-

tilating plant of a rubber mill at Conshohocken, Pa. Ills. 1500 w. Heat & Vent Mag—May, 1912. No. 33090.

Heating Systems

The Time Required to Heat Large Buildings to Normal Temperature. Peter L. Tea. Devises a method by which the amount of radiating surface required to heat a given interior in a given time can be calculated. 2000 w. Heat & Vent Mag—May, 1912. Serial. 1st part. No. 33089.

Time Element in Heating Apparatus. James A. Donnelly. Read before the Am. Soc. of Heat & Vent. Engrs. Calculations and records of observations on time required to bring room temperatures to a given degree. 1500 w. Met Work—May 24, 1912. No. 33039.

Modern Applications of Exhaust Steam by the Combination of Light and Power Plants with Heating Systems (Moderne Abdampfverwertung bei Verbindung von Licht- und Kraftanlagen mit Heizungsanlagen). Max Arbeiter. Examples of such practice and possibilities for development. Ills. 4400 w. Elektrotech u Maschinenbau—April 14, 1912. No. 32733 D.

Hot-Water Heating

Hot-Water Heating for Institutions. Ira N. Evans. Discusses the proper way to design a system of this kind. Ills. 3500 w. Power—May 14, 1912. No. 32863.

Some Types of Furnaces for Heating with Hot Water (Quelques types de chaudières pour le chauffage à l'eau chaude). F. Andrel. Brief review of ten types of furnace systems. Ills. 3000 w. Rev Indus—April 20, 1912. No. 32773 D.

Refrigeration

Standardization of Flanges for Ammonia Refrigeration Equipment. A. M. Howser. Read before the Am. Assn. of Refrig. Discusses points to be considered in adopting a new standard. 1500 w. Power—May 21, 1912. No. 32963.

Central Refrigerating Plants at Atlanta, Ga. R. C. Turner. Brief illustrated description. 1000 w. Power—May 7, 1912. No. 32643.

Electrical Refrigeration for Florists. R. L. Lloyd. Illustrates and describes the arrangements. 1500 w. Elec Rev & W Elect'n—May 4, 1912. No. 32601.

Electric Refrigeration in the Ice-cream Business. Illustrated description of motor-driven refrigerating machines, comparing this method with old methods. 2000 w. Elec Rev & W Elect'n—May 25, 1912. No. 33085.

See also Cold-Storage, under *Heating and Cooling*.

Ventilation

Ventilation as Observed by a City Health Department. M. T. Stevens. An account of conditions found in various buildings. 2000 w. Heat & Vent Mag—May, 1912. No. 33091.

Ventilation Problems in Hospitals and Schools. W. Gilman Thompson. Discusses when mechanical ventilation systems are desirable, methods of studying the fitness of the air for respiration, etc. 2500 w. Heat & Vent Mag—May, 1912. Serial. 1st part. No. 33088.

See also Air Conditioning, under *Heating and Cooling*.

HYDRAULIC MACHINERY

Air Lift

Raising Water by Compressed Air. Frank Richards. Considers the direct-acting pump and its deficiencies and related matters. The next number will describe two types of air lift system. 2000 w. Power—May 14, 1912. No. 32860.

The Air Lift. Frank Richards. Explains the principle of operation and details. 2800 w. Compressed Air—May, 1912. No. 33092.

Hydraulic Ram

The Blasius Theory of a New Hydraulic Ram for Large Volumes of Water. Carl F. Dietz. Presents the work of Blasius, as published in *Glaser's Ann. für Gewerbe und Bauwesen*. Ills. 3000 w. Stevens Ind—Jan, 1912. No. 33024 D.

The Hydraulic Ram: Its Possibilities of Development and Use. Stirling B. Hill. Abstract of paper before the Pacific N-W. Soc. of Engrs. Describes the essential features and operation, discussing its efficiency, limitations and possibilities. Ills. 6000 w. Can Engr—May 23, 1912. No. 33145.

Pumps

An Uncommon Type of Pump. Brief illustrated description of a horizontal treble ram-pump. 250 w. Engr., Lond—May 3, 1912. No. 32893 A.

Turbines

Modern Hydraulic Turbine Practice. Illustrates and describes some new types. 1200 w. Sci Am Sup—May 25, 1912. No. 33049.

Some High Power Hydraulic Turbines. H. B. Taylor. Illustrated description of the 9000 and 22500 h. p. units for the Washington Water Power Co. 2000 w. Eng Rec—May 25, 1912. No. 33074.

Valve Operation

See Valve Control, under ELECTRICAL ENGINEERING, *Power Applications*.

MACHINE ELEMENTS AND DESIGN

Ball Bearings

The Manufacture of Balls for Ball Bearings. L. B. Winton. Brief description of the stages of manufacture of the steel balls used. 700 w. Yale Sci M—May, 1912. No. 33072 C.

The Manufacture of Steel Balls. E. A. Suverkrop. Illustrates and describes the forging, grinding, lapping and gaging methods used in a factory whose capacity is a million balls per week. 2000 w. Am Mach—May 2, 1912. No. 32523.

Cams

See same heading, under *Automobiles*.

Gears

Oscillating Crank-Gear (Die oszillierende Kurbelschleife). W. L. Thele. Calculations on the design of the driving mechanism of small planers. Ills. 4000 w. *Zeit f Werkzeug*—April 15, 1912. No. 32717 D.

See also Worm Gears, under *Machine Elements and Design*.

Lifting Bails

The Design of Large Lifting Bails. Axel K. Pedersen. Gives an approximate method sufficiently close for practical purposes. 2000 w. *Am Mach*—May 23, 1912. No. 33009.

Machine Design

The Factor of Thrusts in Machine Design. Will O. Wynne. Discusses arrangements for counteracting the thrust of one member by that of another, urging more consideration of this subject. Ills. 1500 w. *Mach, N Y*—May, 1912. No. 32519 C.

Springs

Compression Springs and Materials. R. A. Peebles. Considers the principal sources of error in commercial, helical compressing springs. 2000 w. *Am Mach*—May 2, 1912. No. 32526.

The Design of Conical Helical Springs. E. R. Morrison. Develops formulae applicable to the various types. Considers only round bar coils. Supplement. 2500 w. *Mach, N Y*—May, 1912. No. 32517 C.

Worm-Gears

Heating and Heat Dissipation in Worm-Gears. B. J. Shillito. Shows that heating of worm-gearing can be predicted from a formula similar to that used to give temperature of electrical machinery, such as field coils. 1800 w. *Elect'n, Lond*—April 19, 1912. No. 32496 A.

Making Worm-Gears in Great Britain. J. W. Chubb. Drawings and description of English shop practice. 2500 w. *Am Mach*—May 9, 1912. No. 32663.

MACHINE WORKS AND FOUNDRIES**Accident Prevention**

Suggestions for Preventing Foundry Accidents. W. H. Cameron. From a paper read before the Pittsburgh Found. Assn. An account of methods of the Am. Steel Foundries in solving the problem. 4000 w. *Foundry*—May, 1912. No. 32558.

Safety Considerations in Industrial Engineering. David S. Beyer. Discusses problems encountered in endeavoring to provide for accident prevention, particularly in its relation to the science of engineering. Ills. 30000 w. *Pro Engrs Soc of W Penn*—April, 1912. No. 33119 D.

See also Safety Devices, under *Machine Works and Foundries*.

Air Tools

The Use of Compressed Air in Boiler Shops. Thomas Aldcorn. Read before the Am. Boiler Mfrs'. Assn. Considers the production, transmission and use of air and air tools. 5000 w. *Boiler Maker*—May, 1912. No. 32697.

Boiler Shops

Modern Boiler Shops and How the Same Should Be Equipped. H. C. Meinholtz. Read before the Am. Boiler Mfrs. Assn. Suggestions. 2000 w. *Boiler Maker*—May, 1912. No. 32801.

The Modern Boiler Shop and Its Equipment. H. C. Meinholtz. Read before the Am. Boiler Mfrs. Assn. Discusses the construction and general arrangement of the buildings, tools and departments. 1200 w. *Ir Trd Rev*—May 16, 1912. No. 32903.

Boring Mills

The Design of Turning and Boring Mills. Thomas R. Shaw. Describes this type of machine tool and the work it performs, discussing the design. Ills. 3,000 w. *Prac Engr*—April 19, 1912. Serial. 1st part. No. 32490 A.

Brass Founding

A Brass Foundry of Modern Appointments. Illustrates and describes a three-story addition to a Philadelphia plant, giving 2,000,000 lb. yearly casting capacity. 1500 w. *Ir Age*—May 23, 1912. No. 33050 C.

Case-Hardening

Case Hardening Iron with Solid Carbon (Sur la Cémentation du Fer par le Carbone Solide). G. Charpy and S. Bonnerot. Results of experiments in the use of amorphous carbon, graphite and diamond. Ills. 5500 w. *Rev de Metall*—May, 1912. No. 32754 H.

Castings

See Molding, under *Machine Works and Foundries*.

Cupolas

Cupola Linings, Fluxes, and Slag. M. Albuetz. Discusses the construction and material of cupola lining, the nature of fluxes, formation of slag, the effect of fluxes on castings, etc. Ills. 2200 w. *Prac Engr*—May 10, 1912. Serial. 1st part. No. 32974 A.

The Proper Equipment of a Cupola. From *Giesserei Zeitung*. Detailed discussion of features of cupola management. 3000 w. *Castings*—May, 1912. No. 32968.

Dies

Dies for Raised Letter Name Plates. Chester L. Lucas. Illustrates and describes methods used. 2500 w. *Mach, N Y*—May, 1912. No. 32522 C.

Foundries

The Niles Tool Works New Foundry. Illustrated description of an addition to the plant at Hamilton, Ohio, and the special facilities. 1800 w. *Ir Age*—May 9, 1912. No. 32659 C.

Foundry Mixers

Recent Mixer Plants (Neuere Mischanlagen). Description of new electric foundry mixers put out by the Deutsche Maschinenfabrik A. G. in Duisberg. Ills. 2000 w. *Oest Zeit f Berg u Hüttenwesen*—April 20, 1912. No. 32703 D.

Foundry Practice

"Burning On" in Steel. J. S. Hughes. A record of results of experiments carried out in a novel process. 1000 w. Engng—April 19, 1912. No. 32467 A.

American Foundry Practice (Ueber amerikanische Giessereiverhältnisse). C. Humperdinck. Review of conditions found by a traveler in America inspecting American foundries. Ills. 3800 w. Stahl u Eisen—April 25, 1912. No. 32700 D.

Notes on the History of Iron Casting in the 16th Century (Zur Geschichte der Eisengiesserei im 16. Jahrhundert). Paul Martell. An interesting review of methods in use at that period. 2000 w. Giess Zeit—April 15, 1912. No. 32708 D.

Grinding

Grinding. J. J. Guest. Read before the Inst. of Auto. Engrs. Considers the reasons that have caused the comparatively sudden development and the present position of the process. 800 w. Prac Engr—May 10, 1912. Serial. 1st part. No. 32975 A.

Some Notes on Abrasive Wheels. George W. Burley. Illustrated article, giving information concerning abrasive materials and their forms and uses. 2000 w. Mech Wld—April 26, 1912. Serial. 1st part. No. 32838 A.

Jigs

Jigs for Newspaper Folding Machine. F. A. Stanley. Illustrates and describes tools of simple design used in an Omaha shop. 1000 w. Am Mach—May 16, 1912. No. 32868.

Lathes

The Advantage of the Narrow Guide. H. T. Millar. Refers to an earlier article by J. G. Horner on "The Forms of Lathe Beds," and gives an analysis of the conditions of grinding surfaces, particularly the narrow guide. Ills. 1500 w. Mach, N Y—May, 1912. No. 32518 C.

Machine Tools

Cone and Gear Ratios for Machine Tools. H. A. Pearn. Gives tables and formula helpful to designers. 2500 w. Prac Engr—April 19, 1912. No. 32491 A.

Machine Tool Design. Combats statements made in Prof. Nicolson's articles. 2200 w. Prac Engr—April 26, 1912. No. 32834 A.

Positions of Screws in Machine Tools. Considers the best positions in lathes, screw-planing machine, etc. Ills. 1200 w. Prac Engr—May 3, 1912. Serial. 1st part. No. 32875 A.

Standardization of Machine Tools. E. H. Fish. Considerations from both the maker's and users' viewpoints. 2000 w. Am Mach—May 2, 1912. No. 32529.

Making a Comptograph Type-Bar. Glenn Muffy. Illustrated description of a small multiple-spindle drilling machine designed to roll the figures into the curved face of the type-bar. 2500 w. Am Mach—May 9, 1912. No. 32664.

Manufacturing Cotton Gin Parts. Ethan Viall. Illustrates and describes special machines and their uses. 2500 w. Am Mach—May 16, 1912. No. 32865.

Milling Cutters

Re-Cutting Milling Cutters Without Annealing. F. B. Jacobs. Illustrated explanation of methods of re-cutting their milling saws, and of the end teeth of large end mills. 1500 w. Mach, N Y—May, 1912. No. 32515 C.

Molding

American and European Molding Machine Practice. E. V. Ronceray. Discusses features of various mechanical aids to molding operations. Ills. 2500 w. Castings—May, 1912. No. 32967.

Molding Cylinders on an Electric Jar-Rammer. Illustrates and describes how a large number of gasoline engine cylinders were successfully made. 1000 w. Foundry—May, 1912. No. 32560.

Molding Large Castings in an English Foundry. Illustrates and describes methods of molding sections for turbines and engines for marine service. 1200 w. Foundry—May, 1912. No. 32559.

Molding Ornamental Bronze Castings. C. Vickers. Illustrates and describes accurate reproduction by the lost wax process as practiced in modern foundry works. 3500 w. Foundry—May, 1912. No. 32561.

Innovations in the Bonvillain Molding Machines (Neuerungen an Bonvillainschen Formmaschinen). U. Lohse. Review of recent improvements in the machines put out by this company. Ills. 2400 w. Stahl u Eisen—April 25, 1912. No. 32701 D.

Molds

Green-Sand Molds Without Patterns. From *Eisen Zeitung*. Describes method. 1000 w. Mech Wld—April 19, 1912. No. 32485 A.

Some Recent Developments in Permanent Molds. Illustrates and describes details of an intricate iron mold for casting small projectiles, and a machine for making grate bars. 2000 w. Ir Trd Rev—May 2, 1912. No. 32545.

Patterns

Building an Intricate Burring Machine Pattern. Jabez Noll. Illustrates and describes the development of the model in various stages. 1500 w. Foundry—May, 1912. No. 32562.

Turning Pattern Work in Halves. Illustrates and describes the usual methods. 600 w. Prac Engr—May 3, 1912. No. 32874 A.

Pipe Founding

Casting Pipes Without Cores. Illustrates and describes the process developed by Hermann Molinder. 1700 w. Engr, Lond—May 10, 1912. No. 32996 A.

Planing-Mill

A Modern Motor-Driven Planing Mill. Describes a planing mill at St. Maries,

Idaho, equipped with individual motor drive. Ills. 1000 w. Elec Rev & W Elect'n—May 11, 1912. No. 32824.

Repairs

Handling Repairs Systematically. C. A. Tupper. Suggestions for a system applicable to such work. 2200 w. Am Mach—May 2, 1912. No. 32527.

Safety Devices

Safety Standards for Machine Tools. David S. Beyer. Calls attention to standards that would be mutually beneficial to builders and users of machine tools. Ills. 5000 w. Am Mach—May 9, 1912. No. 32662.

Shop Lighting

Shop Lighting Maintenance Records. C. E. Clewell. Notes suggesting methods for the accounting of costs. Ills. 2000 w. Am Mach—May 16, 1912. No. 32866.

Shop Practice

Cutting-Out Keyways by Hand. W. R. Menzies. Describes methods used by an experienced hand, illustrating by example. 2200 w. Mech Wld—May 10, 1912. No. 32983 A.

The Stripping of Bushes. James Stormouth. Discusses difficulties and the remedies. 2000 w. Mech Wld—April 19, 1912. No. 32484 A.

Building Ice Machinery in the West. F. A. Stanley. Illustrates and describes tools and methods used in an Omaha shop. 1000 w. Am Mach—May 9, 1912. No. 32667.

In a Nashville Automobile Factory. Ethan Viall. Illustrated description of shop practice and appliances. 1000 w. Am Mach—May 23, 1912. No. 33008.

Jig-Boring at the United Shoe Machinery Co.'s Factory. Chester L. Lucas. Illustrates and describes methods used. 1500 w. Mach, N Y—May, 1912. No. 32516 C.

Making Needles for Talking Machines. Fred H. Colvin. Illustrates and describes the process. 1500 w. Am Mach—May 9, 1912. No. 32665.

Manufacturing Automobiles in Iowa. Illustrates and describes methods of machining cylinders for double-opposed engines. 2500 w. Am Mach—May 2, 1912. No. 32525.

Methods of a California Machine Shop. Explains a general system of numbering of all drawings, patterns and machine parts in classes. 2500 w. Am Mach—May 16, 1912. No. 32870.

Watch Movement Manufacture. Douglas T. Hamilton. Illustrates and describes methods employed by the South Bend Watch Co. 3500 w. Mach, N Y—May, 1912. Serial. 1st part. No. 32514 C.

Shops

A Southern Circular Saw Factory. Ethan Viall. Gives details of machines and methods used in making solid and inserted-tooth circular saws. Ills. 2500 w. Am Mach—May 2, 1912. No. 32524.

New Factory of Bosch Magneto Co. Illustrated description of a new factory at Springfield, Mass. 3300 w. Am Mach—May 16, 1912. No. 32869.

Spike Machine

The Farrow-Spike Machine. Illustrates and describes interesting details of an improved automatic type of the Farrow railroad spike machine. 1200 w. Ir Age—May 16, 1912. No. 32901 C.

Tools

Special Tools in the 'Frisco Shops. F. A. Stanley. Illustrations with brief descriptions. 1000 w. Am Mach—May 2, 1912. No. 32528.

Welding

Autogenous Welding for Repairing Boilers. Henry Cave. Describes the equipment and methods. Ills. 1700 w. Locomotive—April, 1912. No. 33186.

Welding Up of Blowholes and Cavities in Steel Ingots. J. E. Stead. Read before the Iron & Steel Inst. Describes experiments made to determine whether real blowholes in crucible steel ingots could be perfectly welded. Ills. 2500 w. Mech Engr—May 10, 1912. No. 32978 A.

Wire Drawing

The Theory of the Drawing of Metal Wires (Teoria della trafilatura dei file metallici). Ernesto Ascione. Mathematical discussion on tensile effects. Diagrams. Serial. 1st part. 1800 w. Industria—April 28, 1912. No. 32794 D.

MATERIALS OF CONSTRUCTION

Alloys

Alloys of Aluminum and Zinc. Dr. Walter Rosenheim and S. L. Archbutt. Summary of the tenth report to the Alloys Research Committee of the Inst. of Mech. Engrs. on the alloys of aluminum and zinc, with an appendix on a ternary alloy of aluminum with zinc and copper. 5000 w. Inst of Mech Engrs—April 19, 1912. No. 32847 N.

Institution of Mechanical Engineers. A summary of the main points of the tenth report to the Alloys Research Committee, presented by Dr. Walter Rosenheim and S. L. Archbutt, showing its nature and scope. 500 w. Engr, Lond—April 26, 1912. No. 32849 A.

Alloy Steel

The Chemical and Mechanical Relations of Iron, Vanadium, and Carbon. J. O. Arnold and A. A. Read. Read before the Iron & Steel Inst. A continuation of the author's work in this field giving an account of a number of experiments made to determine the composition, the mechanical properties, and the microscopical features. Ills. 2500 w. Ir & Coal Trds Rev—May 10, 1912. No. 33017 A.

Steel and Its Heat Treatment. Robert R. Abbott. Extracts from a paper read before the Cleveland Engrng. Soc. Discusses alloys and critical temperatures, and results of heat treatment. 2000 w. Ir Age—May 9, 1912. No. 32660 C.

Crystallization and Structure of Slowly Cooled Steel (Sur la Cristallisation et Structure des Aciers Refroidis Lentement). M. N. T. Belaiew. Especially concerning structure and crystal formation in alloys of iron and carbon. Ills. 6500 w. *Rev de Metall*—May, 1912. No. 32755 H.

Ancient Iron

Sinhalese Iron and Steel of Ancient Origin. Sir Robert Hadfield. Read before the Iron & Steel Inst. Describes interesting specimens found in Ceylon and gives information of interest concerning articles in the Colombo Museum, and opinions of various authorities. Ills. 11000 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33014 A.

Cast Iron

A New Theory Considered for Cast Iron Testing. From *Stahl und Eisen*. Considers the influence of the method of pouring the casting and time of cooling. Gives results of tests and conclusions. 2000 w. *Castings*—May, 1912. No. 32966.

Steel Fractures

Note on the Investigation of Fractures. F. Rogers. Read before the Iron & Steel Inst. Explains a method of printing from a fractured piece of steel and its use. Ills. 1700 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33022 A.

Steel

The Structural Composition and Physical Properties of Steel. Albert Sauveur. Considers slowly cooled steel, chemical vs. structural composition, physical properties of the structural constituents, steel of maximum strength, and ductility of steel vs. its structural composition. 2000 w. *Jour Fr Inst*—May, 1912. No. 33202 D.

Manufacture and Treatment of Steel for Guns. L. Cubillo. Read before the Iron & Steel Inst. Considers the conditions of the steel required, its melting, and treatment. Ills. 9800 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33021 A.

Notes on the Solubility of Cementite in Hardenite. John Oliver Arnold and Leslie Aitchison. Read before the Iron & Steel Inst. Illustrated report of research work. 700 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33016 A.

Tool Steels

The Influence of Heat on Hardened Tool Steels: With Special Reference to the Heat Generated in Cutting Operations. Edward G. Herbert. Read before the Iron & Steel Inst. Describes experiments and attempts to connect the observed changes in the cutting durability with changes in the physical properties as shown by breaking tests at various temperatures. 5000 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33015 A.

MEASUREMENT

Charts

Closed Heaters, Surface Condensers. Edward T. Turner. Gives a chart for de-

termining the amount of condensing surface required. 700 w. *Power*—May 7, 1912. No. 32642.

Drafting

A Modern Drafting-Room System. Grandon G. Gates. Gives a brief description of method in use at Seneca Falls, N. Y., and also of the drafting-room and its equipment. 2000 w. *Am Mach*—May 9, 1912. No. 32666.

Dynametry

The Measurement of Dynamic Action and Its Application to the Maintenance of Railways (Mesure des Actions Dynamiques et son Application au Contrôle Permanent des Voies Ferrées). M. L. Schlüssel. A study of dynametry, with notes on its use for detecting and locating irregularities in the roadway. Diagrams. 12800 w. *Mem Soc Ing Civ de France*—Feb, 1912. No. 32751 G.

Load-Gages

A Simple Load-Weighing Apparatus for Large Testing Machine. Illustrates and describes a new form of load-weighing mechanism developed in Europe. 1200 w. *Eng News*—May 16, 1912. No. 32915.

Pyrometers

Pyrometers and Boiler Efficiency. C. F. Busse. Shows that suitably placed pyrometers make it possible to regulate boiler operation to secure best economy. Ills. 1500 w. *Power*—May 21, 1912. No. 32960.

Steam Meters

A New Steam Meter. Illustrated description of the Curnon steam meter and its operation. 1000 w. *Engr, Lond*—May 3, 1912. No. 32891 A.

Testing Machine

A 3300-Ton Testing Machine. Longitudinal section, plan, and cross-section of the new German machine at the Prussian Testing Institution. 800 w. *Eng News*—May 2, 1912. No. 32568.

Thermometers

See Iceberg Detection, under MARINE AND NAVAL ENGINEERING.

POWER AND TRANSMISSION

Air Compressors

Increasing the Efficiency of Air Compressors. S. R. Stone. Discusses the essentials to economy in air compression. Ills. 2500 w. *Min & Engng Wld*—May 18, 1912. No. 32953.

Volumetric Efficiency of Air Compressors. F. D. Holdsworth. Illustrates and describes an apparatus used in determining compressor efficiencies by volumetric methods. 1500 w. *Eng & Min Jour*—May 25, 1912. No. 33082.

Acceptance Tests on an Electrically Driven Piston Compressor (Abnahmeversuche an einem elektrisch angetriebenen Kolbenkompressor). Report of method of tests and results obtained on two air compressors. Ills. 2400 w. *Glückauf*—April 20, 1912. No. 32705 D.

Belting

"Titan" Belts (Les Courroies "Titan"). Leon Masson. Examples of the application of the Magaldi reinforcement to leather belts. Ills. 7000 w. Bul Soc d'Encour—May, 1912. No. 32745 E + F.

Compressed Air

See Air Tools, under *Machine Works and Foundries*; and Compressed Air, under MINING AND METALLURGY, *Mining*.

Costs

Inquiries into the Costs of Power with Several, Separated, Independent Driving Mediums (Unkostenermittlung in Betrieben mit mehreren voneinander unabhängigen Betriebsabteilungen). C. M. Lewin. Tables and methods for determining such costs. Serial. 1st part. 2200 w. Zeit f Werkzeug—April 15, 1912. No. 32716 D.

Gas Power

Extensive Use of Coke-Oven Gas. C. A. Tupper. From *Coal Age*. Illustrates and describes applications of gas power in Germany and France. 2000 w. Power—May 21, 1912. No. 32962.

See also Gas-Engine Power, under MINING AND METALLURGY, *Mining*.

Power Plant Records

Power Plant Recording System. L. R. W. Allison. Gives forms and methods used for indexing material received, on hand and issued. 1000 w. Power—May 7, 1912. No. 32641.

Power Plants

Simple Methods for Increasing Efficiency in Small Power Plants. L. B. Webster. Brief description of a simple arrangement for making the engine governor more sensitive to variations in the load, the improved regulation giving greater efficiency and economy. 1000 w. Elec Wld—May 4, 1912. No. 32616.

Aeolian Company's New Power Plant. Warren O. Rogers. Illustrates and describes a remodeled high-speed engine plant at Garwood, N. J. 1200 w. Power—May 14, 1912. No. 32859.

Rope Brakes

Rope Brakes, Construction and Design. Julian C. Smallwood. Drawings and description of several arrangements, with directions for using them and for calculating the horsepower. 3500 w. Power—May 28, 1912. No. 33155.

Rope Driving

The Transmission of Power by Cotton Ropes. R. E. Hart. From a paper before the Assn. of Engrs. in Charge. Discusses the difficulties of rope-driving and their solution. 3000 w. Mech Wld—April 12 and 19, 1912. Serial. Two parts. No. 32483 each A.

STEAM ENGINEERING**Boiler Design**

The Importance of the Furnace in Boiler Design. Charles S. Lynch. Brief discussion of the distance of crown sheet from grate bars. 1200 w. Boiler Maker—May, 1912. No. 32800.

Efficiency of Joints in Boiler Shells. H. L. Strong. Calculations showing how to figure the efficiencies of both lap and butt joints with single, double and quadruple riveting. 2000 w. Power—May 14, 1912. No. 32864.

Boiler Efficiency

Notes on Steam Boiler Efficiency. Edward A. Uehling. From a paper read before the Mas. Mech. Assn. of Am. Compares boilers under test conditions with those under working conditions. 2500 w. Power—May 28, 1912. No. 33157.

Boiler Inspection

Boiler Inspection Law, State of Ohio. H. A. Baumhart. Discusses the law that went into effect Jan. 1, 1912. 2000 w. Locomotive—April, 1912. No. 33185.

Boiler Tubes

Manufacture of Seamless Steel Boiler Tubes. J. Jay Dunn. Read before the Am. Boiler Mfrs.' Assn. Describes the process now used and reviews earlier processes which have been superseded. 3500 w. Boiler Maker—May, 1912. No. 32698.

History of Charcoal Iron and the Manufacture of Charcoal Iron Boiler Tubes. George Thomas, 3d. Read before the Am. Boiler Mfrs.' Assn. 2500 w. Boiler Maker—May, 1912. No. 32699.

Boiler Washing

Locomotive Boiler Washing. C. E. Lester. Discusses feed water troubles and wash-out regulations. Ills. 2000 w. Boiler Maker—May, 1912. No. 32696.

Boiler Waters

Water Treatment and Boiler Troubles. W. A. Pownall. Discusses causes and remedies for boiler troubles, the advantages and disadvantages of water treatment, and a method of treatment that will give good results. General discussion. 13000 w. Pro W Ry Club—April 16, 1912. No. 33190 C.

Locomotive Boiler Corrosion and Treated Water. J. R. Francis. An account of corrosion trouble on the Peoria and Eastern division of the Big Four R. R., the investigation and remedy. 3500 w. Ry & Engng Rev—May 4, 1912. No. 32603.

The "Luminator" Treatment of Water. Henry B. Lake. From *Jour. Soc. of Chem. Ind.* Gives results of experiments to discover the effect of passing water over aluminum, and states conclusions. Discussion. 2000 w. Chem Engr—May, 1912. No. 33138 C.

Coal Economy

Economies in Coal for Steam Production. S. J. A. Mills. Discusses the purchase and efficient use of coal for steam boilers. 1500 w. Mech Wld—May 10, 1912. Serial. 1st part. No. 32984 A.

Condensers

Kinetic Theory of Gases and Steam. W. H. Booth. Explains the action of steam in a condenser and in an engine cylinder. 1500 w. Power—May 14, 1912. No. 32861.

Ejector Condensers. Samuel Bullock. Read before the E. of Scotland Branch of the Assn. of Min. Elec. Engrs. Considers types of condensers and describes the Körting multi-jet ejector condenser. Ills. 4500 w. *Ir & Coal Trds Rev*—April 26, 1912. No. 32854 A.

Steam-Condensing Equipments. A. G. Christie. Read before the Univ. of Toronto Engng. Soc. Explains in detail the condensing problem and the requirements of a plant, illustrating and describing types of condensers. 6000 w. *Mech Engr*—May 10, 1912. No. 32981 A.

Economizer

The Fuel Economizer. F. F. J. Maguire. Explains the advantages of the apparatus in operating costs and conditions. Ills. 4000 w. *Engineering Magazine*—June, 1912. No. 33131 B.

Engine Design

The Development of the Steam Engine Since 1900 (*L'Évolution de la Machine à Vapeur depuis 1900*). M. E. Hohn. Review of recent advances in steam engineering. Ills. 8500 w. (Supplement.) *Tech Mod*—May 15, 1912. No. 32770 D.

Engine Economy

Steam Engines for Driving Reversing Rolling Mills. John W. Hall. Read before the Iron & Steel Inst. Explains the duty demanded and discusses the best method and the best engine for the work. 4000 w. *Ir & Coal Trds Rev*—May 10, 1912. No. 33020 A.

The Paxman-Lentz Mill Engine. Illustrated description of an engine claiming the utmost economy in steam consumption. 1000 w. *Mech Wld*—May 3, 1912. No. 32880 A.

Experiences at a Thermo-Electric Plant in Utilizing Intermediate Steam (*Esperienze su di un impianto termoelettrico con utilizzazione del vapore intermedio*). G. Ghersina. Describes design of plant and its operation, with results. Ills. Serial. 1st part. 1400 w. *Industria*—April 14, 1912. No. 32793 D.

Feed Pumps

Calculating the Sizes of Feed Pumps. Victor C. Vance. Illustrates by example, calculating the size of a boiler-feed pump for a typical installation. 1500 w. *Power*—May 21, 1912. No. 32961.

Flue Gases

The Question of the Application of Flue Gas from Foundries and Mines for the Purpose of Machine Driving (*Zur Frage der Abgasverwertung auf Hüttenwerken und Zechen unter besonderer Berücksichtigung des Maschinenbetriebes*). Herr Schönburg. The first article deals with the possibilities of the utility of blast-furnace gases. Serial. 1st part. 2200 w. *Elektrotech Rundschau*—April 25, 1912. No. 32738 D.

Fuels

Surface Combustion. Editorial review of the lecture by Prof. William A. Bone,

at Leeds University, on some of the newer applications of the principle of surface combustion. 3000 w. *Engng*—May 10, 1912. No. 32988 A.

The Effect of Temperature in the Carbonization of Coal, and Its Bearing Upon the Conservation of Our Coal Supplies. Vivian B. Lewes. From report of British Science Guild on "Natural Sources of Energy." 1500 w. *Mech Engr*—April 26, 1912. No. 32837 A.

Indicator Diagrams

Combined Indicator-Diagrams. H. Keay Pratt. Explains how to construct such diagrams and the object. 3000 w. *Mech Wld*—April 19, 1912. No. 32486 A.

Mechanical Stokers

Automatic Stokers (I Focolari Automatici). Carlo Solari. Review of some of the more important European and American devices. Ills. Serial. 1st part. 4800 w. *Monit Tecnico*—May 10, 1912. No. 32792 D.

Regulators

The Regularity and Regulation of Steam or Gas Engines (*Sur la Régularité et les Régulateurs des Moteurs à Vapeur ou à Gaz*). Ch. Reignier. A review of several types of regulators as applied to steam or gas engines. Ills. 3600 w. *Rev de Méc*—April 30, 1912. No. 32762 E + F.

Superheating

Inquiry into the Researches of Armand Duchesne on the Properties of Superheated Steam (*Examen des Recherches de M. Armand Duchesne sur les Propriétés de la Vapeur d'Eau Surchauffée*). V. Dwelshauvers-Dery. A critical review of the work of Duchesne in this line. Diagrams. 7800 w. *Rev de Méc*—March 31, 1912. No. 32760 E + F.

A Reply to Certain Criticisms on My Researches on the Properties of Superheated Steam (*Réponse à Certaines Critiques Faites à mes Recherches sur les Propriétés de la Vapeur d'Eau Surchauffée*). Armand Duchesne. In which is stated the points of difference in the author's theory with those previously expressed. Diagrams. 4200 w. *Rev de Méc*—March 31, 1912. No. 32761 E + F.

Thermodynamics

Reversibility in Relation to Entropy and to Adiabatic Processes. Aims to point out an unambiguous method of defining and using these terms. 2500 w. *Engr, Lond*—May 3, 1912. No. 32887 A.

Turbines

The Present State of Development of Large Steam Turbines. A. G. Christie. Deals with leading types, some details of construction, the commercial results obtained, and new uses. 9500 w. *Jour Am Soc of Mech Engrs*—May, 1912. No. 33212 D.

Geared Steam Turbine for the Rölling Mill. Illustrated description of a turbine at Calderbank Steel Works, Scotland, connected to the mill through two sets of

reduction gears and using live and exhaust steam. 1200 w. *Ir Age*—May 16, 1912. No. 32900 C.

Radial-Flow Steam Turbines. Mathematical analysis of turbine performance. 2000 w. *Engng*—May 3, 1912. No. 32882 A.

The Ljungström Reaction Steam Turbine (La Turbine a Vapeur a Réaction, Système Ljungström). Illustrated description of this Swedish design. Plate. 38000 w. *Génie Civil*—May 18, 1912. No. 32785 D.

The Belluzzo Steam Turbine in Operation (Le turbine a vapore Belluzzo per impianti fissi). Description of operation and efficiency of this turbine. Ills. Serial. 1st part. 2300 w. *Industria*—May 12, 1912. No. 32795 D.

See also Steam Turbines, under MARINE AND NAVAL ENGINEERING.

TRANSPORTING AND CONVEYING

Coal Handling

New Coal Loading Appliance at Sunderland Docks. Illustrated description of a novel appliance designed to handle the coal with the minimum of breakage. 3000 w. *Engr, Lond*—April 26, 1912. No. 32850 A.

Cranes

Lattice Braced Crane Jibs. Shows how to calculate the cross section for a braced jib, and how one or two bracing formulæ might be applied. Ills. 1500 w. *Mech Wld*—April 26, 1912. No. 32840 A.

Crane Construction for Work Shops (Ueber Kranbauformen für Werkstätten). Hubert Hermanns. Illustrated description of large travelling cranes for foundries and machine works. 1600 w. *Gress Zeit*—April 15, 1912. No. 32707 D.

Freight Handling

Handling Freight from Ships' Holds to Cars and Warehouses, Using Motor Trucks. Describes the system in operation on the Savannah docks. Ills. 2000 w. *Eng Rec*—May 25, 1912. No. 33075.

MINING AND METALLURGY

COAL AND COKE

Alberta

Coal-Mining in Alberta in 1910. A comparison of output during recent years. 800 w. *Col Guard*—April 17, 1912. No. 32479 N.

Analysis

The Causes for Variations in Volatile Matter Determinations. S. W. Parr. Considers the conditions causing variation and their control, the most important being the speed of decomposition in the early carbonization of the coal. 1600 w. *Chem Engr*—May, 1912. No. 33139 C.

Australia

The State Coal Mine, Wonthaggi, Victoria, Australia. Charles M. Clark. De-

MISCELLANY

Address

Ostwald's Energetics as a Moral Force and Law, and Ives Colorimeter and Color Photography. Henry Hess. Presidential address. 7500 w. *Pro Engrs' Club of Phila*—April, 1912. No. 33116 D.

Agricultural Machinery

Machines at the General Agricultural Exhibit (Les Machines au Concours Général Agricole). H. Pillaud. The first part discusses the exhibits of tractor plows. Ills. Serial. 1st part. 3600 w. *Tech Mod*—April 15, 1912. No. 32768 D.

New Methods for Mechanical Plowing (Nouveau Procédé de Labourage Mécanique). Louis Petit. Illustrates new features in the use of tractor plows. Discussion by M. Julien. 8000 w. *Bul Soc d'Encour*—April, 1912. No. 32747 E + F.

See also Agriculture, under ELECTRICAL ENGINEERING, *Power Applications*.

Artillery

The Question of Light Field Howitzers (La Question de l'Obusier Léger de Campagne). D. Renaud. Description of the Schneider rapid-fire, field howitzer of 105 millimeter bore. Ills. 5500 w. *Génie Civil*—May 11, 1912. No. 32783 D.

Flour Milling

Flour Milling and Mill Engineering. Abstract of paper by B. W. Diedrick and of the discussion. 1800 w. *Jour Am Soc of Mech Engrs*—May, 1912. No. 33215 D.

Standardization

Standardization in Manufacturing. H. F. Chadwick. Explains some of the standard methods evolved by the Westinghouse Company. Ills. 1000 w. *Elec Jour*—May, 1912. Serial. 1st part. No. 33207.

Tile Molding

Molding External-flange Cylinder or Large Flange Pipe in Loam. Drawings and description. 1000 w. *Mech Wld*—April 26, 1912. No. 32839 A.

tailed description of the mine and its equipment. 1700 w. *Col Guard*—April 26, 1912. No. 32841 A.

Briquetting

See same heading, under *Ore Dressing and Concentration*.

British Columbia

Bear River Coal Field, B. C. C. F. J. Galloway. A detailed description of this promising field. 800 w. *Can Min Jour*—May 15, 1912. Serial. 1st part. No. 32964.

Coal-Mining in British Columbia in 1911. Extracts from the "Preliminary Review and Estimate of Mineral Production for Year 1911." 2000 w. *Col Guard*—April 17, 1912. (Special.) No. 32478 N.

Canada

The Coal Resources of Canada. A summary account from the Report of the Commission of Conservation, published in 1911. 3500 w. Col Guard—April 17, 1912. (Special.) No. 32476 N.

The Coal Production of Canada. Information from official reports of 1910 and 1911. 2500 w. Col Guard—April 17, 1912. (Special.) No. 32477 N.

See also Province in question, under *Coal and Coke*.

Competition

International Coal Competition. Read before the Can. Min. Inst. Reviews statistics of production and distribution. 4000 w. Col Guard—April 17, 1912. No. 32481 N.

Electric Power

Earthed v. Insulated Neutrals in Colliery Installations. Robert W. Peters. Read before the Assn. of Min. Elec. Engrs. (E. of Scotland Branch). Presents the advantages of each system, and considers how the question affects generating plant and overhead transmission lines. 2000 w. Ir & Coal Trds Rev—April 19, 1912. No. 32460 A.

Explosions

Bruceton, Pa., Explosion. George S. Rice. Map, and description of the explosion test at the Experimental Mine, on Feb. 24, 1912. 2500 w. Mines & Min—May, 1912. No. 32540 C.

Mine Explosion at McCurtain, Okla. A. A. Steel. Report on this disaster explaining conditions and probable cause, and describing the rescue work. Maps. 8000 w. Mines & Min—May, 1912. No. 32539 C.

Report of the Bignall Hill Colliery Explosion. Describes the colliery and the cause of the explosion occurring Nov. 25, 1911, a gas explosion originating from a gob fire, the rescue operations, etc. Map. 7500 w. Col Guard—May 3, 1912. No. 32881 A.

The Jed, W. Va., Mine Explosion. Illustrated account of an explosion due probably to gas, influenced by change of barometer and local conditions. 6000 w. Mines & Min—May, 1912. No. 32537 C.

Great Britain

The Coal Resources of Great Britain. Dr. G. T. Belby. Report to the British Science Guild on "Natural Sources of Energy." 3000 w. Mech Engr—May 10, 1912. No. 32979 A.

Mine Fires

Gas Analysis as an Aid in Fighting Mine Fires. George A. Burrell and Frank M. Seibert. States conclusions based on extensive investigations. 4500 w. U S Bureau of Mines—Tech. paper No. 13. No. 33175 N.

Nova Scotia

Coal-Mining in Nova Scotia in 1911. Reports production and distribution during the fiscal year. 900 w. Col. Guard—April 17, 1912. (Special.) No. 22480 N.

Peat

See Peat Power, under *MECHANICAL ENGINEERING, Combustion Motors*.

Scranton, Pa.

Mining Conditions Under the City of Scranton, Pa. Report and maps by William Griffith and Eli T. Conner, with a preface by Joseph A. Holmes and a chapter by N. H. Darton. Ills. 89 pages. U S Bureau of Mines—Bul. 25. No. 33159 N.

Trade

Influence of Panama Canal Upon Coal Trade. H. Foster Bain. Read before the Can. Min. Inst. Discusses the effect on fuel distribution on the new trade alignment expected to follow the opening of the canal. 2500 w. Col Guard—April 19, 1912. No. 32482 A.

COPPER**Arizona**

Notes on the Miami Copper District, Arizona. Walter Harvey Weed. Notes on the economic peculiarities of this district. 2500 w. Min & Engng Wld—May 18, 1912. No. 32954.

Work of the Ray Consolidated. D. C. Jackling. Information from the annual report for period ending Dec. 31, 1911. Describes this copper property, recent improvements and development. Ills. 3000 w. Min & Sci Pr—May 15, 1912. No. 33060.

Nevada

Work of the Nevada Consolidated Copper Company. Pope Yeatman. From a report covering fifteen months ending Dec. 31, 1911, showing results. 2200 w. Min & Sci Pr—May 4, 1912. No. 32677.

Ore Selling

How the Metals Are Sold—Copper. W. R. Ingalls. An account of the practices obtaining in the marketing of an important metal. 4000 w. Eng & Min Jour—May 4, 1912. Serial. 1st part. No. 32590.

Porphyritic Copper

Types of Porphyry Copper Deposits. W. L. Tovote. Discusses the genesis of these deposits, their more important characteristics, etc. 2000 w. Min & Sci Pr—May 18, 1912. No. 33057.

Precipitation

The Oxalate-Permanganate Process for the Determination of Copper Associated with Cadmium, Arsenic, Iron, or Lead. H. L. Ward. Shows methods of precipitation and determination. 3000 w. Am Jour of Sci—May, 1912. No. 33094 D.

Production

Copper: Its Present Position as Regards Production and Price. John B. C. Kershaw. A brief study of the relationship of production, consumption and price. 1000 w. Elec Rev, Lond—May 3, 1912. No. 32872 A.

Rolling Mills

The Manufacture of Brass and Copper at the Plants of Basse & Selve, Altena,

I. W., Germany. Illustrated description of these extensive works which have celebrated their fiftieth anniversary, and review of their history. 2000 w. Brass Wld—May, 1912. No. 33032.

Russia

An American Copper Plant in the Caucasus. An account of a low-grade copper property at Dzansul, Russia. 2000 w. Min & Engng Wld—May 18, 1912. No. 32956.

Russia Copper Production. Reviews the development of the industry and production. 1500 w. Min Jour—April 20, 1912. Serial. 1st part. No. 32489 A.

Smelting

Handling Furnace Charges at Cananea. Morris Jesup Elsing. Illustrated description of methods used at the smelting plant of the Greene-Cananea Copper Co. 1600 w. Min & Sci Pr—May 4, 1912. No. 32674.

Thiogen Process Demonstration. L. H. Eddy. Illustrated description of a small plant at Campo Seco, Cal., for reducing the sulphur oxides in furnace gases to elemental sulphur. 1000 w. Eng & Min Jour—May 4, 1912. No. 32589.

Utah

Work of the Utah Copper Company. D. C. Jackling. From a report to the company for the year ending Dec. 31, 1911, giving information of development, operations, etc. 4000 w. Min & Sci Pr—May 11, 1912. No. 32906.

GOLD AND SILVER

Assaying

Presenting Assay Results by Graphic Methods. J. B. Stewart. Explains a scheme for graphically representing the commercial value of the ore in a mine by combining the factors of available tonnage and the assay value per ton. 3000 w. Min & Sci Pr—May 11, 1912. No. 32904.

California

The Los Burros Mining District. Charles H. Davis. Describes these gold mines, the conditions affecting mining, the development and production. Map. 2500 w. Min & Sci Pr—May 18, 1912. No. 33061.

Dredging

Dredges on Upper American River. Lewis H. Eddy. An account of operations in California dredging fields. Ills. 3000 w. Eng & Min Jour—May 18, 1912. No. 32946.

Gold Dredging in the Folsom Field of California. A. H. Martin. Illustrates dredge used, and gives an account of one of the most important dredging fields in the State. 2500 w. Min & Engng Wld—May 25, 1912. No. 33148.

Korea

Prospecting Gold Placers in Korea. J. J. Martin. Describes prospecting work at the Chiksan mines. Ills. 1800 w. Min & Sci Pr—May 18, 1912. No. 33059.

Mexico

Some Features of Mining in Mexico. C. W. Workman. Address before the Kingston School of Mining. Reviews the history of silver mining in Mexico, describing the mines and methods. 3000 w. Can Min Jour—May 1, 1912. No. 32606.

Some Old Methods in Mexican Mining and Metallurgy. Stanley N. Graham. Illustration with brief description. 700 w. Can Min Jour—May 1, 1912. No. 32607.

Mineral District of Rayon. H. D. Bodington, in *Mex. Min. Jour.* Brief illustrated description of a little known silver region in Mexico which has produced rich ore. 1500 w. Mines & Min—May, 1912. No. 32541 C.

Montana

Notes on the Blue Bird Mine. H. V. Winchell and A. N. Winchell. Particulars relating to the physical appearance of this property, its geology, and history, describing its rocks, minerals, and development. Ills. 2000 w. Ec-Geol—April-May, 1912. No. 33124 D.

Nevada

Report of the Tonopah Belmont Development Company. Financial and statistical statements from the report of the president, for the year ending Feb. 29, 1912. Ills. 1500 w. Min & Sci Pr—May 4, 1912. No. 32676.

Ontario

Mines and Ores of Porcupine. Reginald E. Hore. Describes the ore deposits of the Dome and the Hollinger mines, and of other properties. Ills. 2500 w. Eng & Min Jour—May 4, 1912. No. 32591.

The Gold Fields of New Ontario. Walter Baelz. Trans. from *Zeit. F. Prakt. Geologic*; Vol. XIX. On the discovery, extent, and topography of the gold-bearing region, describing the ore bodies. 4500 w. Can Min Jour—May 1, 1912. No. 32605.

Placers

The Law of the Pay Streak in Placer Deposits. J. B. Tyrrell. Presents results of a study of the placer deposits of the Klondike, believing the laws and principles may be applied to other alluvial deposits. 5000 w. Inst of Min & Met, Bul 92—May 9, 1912. No. 32796 N.

See also Korea, under *Gold and Silver*.

Reduction

A Modern Reduction Plant on the Witwatersrand. Rowland Gascoyne. Brief illustrated description of the plant at the Modderfontein "B" gold property. 1000 w. Min & Engng Wld—May 4, 1912. No. 32611.

Russia

Gold and Platinum Alluvial Deposits in Russia. Leon Perret. Gives statistics and history, methods of prospecting and working, and describes deposits and conditions. 13500 w. Inst of Min & Met, Bul 92—May 9, 1912. No. 32798 N.

"Salting"

The "Salting" of Samples and Means of Detection. George A. James. Calls attention to cases due to ignorance or carelessness. 2000 w. Min & Engng Wld—May 25, 1912. No. 33151.

Sumatra

Gold and Silver in Sumatra. S. J. Truscott. Review of development, describing the geology, ore occurrence, lode characteristics, etc. Map. 7300 w. Min Mag—May, 1912. No. 33102 B.

Yukon

Yukon Gold. O. B. Perry. Report of operations for the year ending Feb. 1, 1912. 1200 w. Min & Sci Pr—May 11, 1912. No. 32905.

IRON AND STEEL**American Progress**

American Iron and Steel Institute. Elbert H. Gary. Presidential address giving a comprehensive view of the relation of the Institute to American progress. 5000 w. Mfrs' Rec—May 23, 1912. No. 33037.

Blast Furnaces

Inland Steel Company's New Blast Furnace. Illustrates and describes details of the second 400-ton furnace at Indiana Harbor, 1200 w. Ir Age—May 9, 1912. No. 32661 C.

See also Dry Blast, under *Iron and Steel*.

Briquetting

See same heading under *Ore Dressing and Concentration*.

Competition

Competition: Its Uses and Abuses. Joseph G. Butler, Jr. Read before the Am. Iron & Steel Inst. Discusses the subject of rivalry in quality and in economics of production. General discussion. 2500 w. Ir Age—May 23, 1912. No. 33052 C.

Contracts

Contract Obligations in the Steel Trade. E. A. S. Clarke. Read before the Am. Iron & Steel Inst. Discusses abuses and suggests remedies. Also discussion. 4000 w. Ir Age—May 23, 1912. No. 33051 C.

Dry Blast

A New Dry Blast Process. John B. Miles. Illustrated description of a dry blast plant at Standish, N. Y., employing a process differing in essentials from any other process tried in practice. 1200 w. Ir & Coal Trds Rev—April 26, 1912. No. 32853 A.

Electrometallurgy

The Electric Furnace and High-Grade Steel. William R. Walker. Read before the Am. Iron & Steel Inst. Reports good results thus far with rails. General discussion. 4000 w. Ir Age—May 23, 1912. No. 33053 C.

The Electric Furnace Process as Applied to the Metallurgy of Steels. Harold G. Ade Stedman. Abstract of a paper before the Cleveland (England) Inst. of Engrs. Considers principles governing

the correct design of electric furnaces and their auxiliary apparatus, with particular reference to continuous running and low operation costs. Ills. 6000 w. Can Min Jour—May 15, 1912. No. 32965.

See also Electric Furnaces, under *ELECTRICAL ENGINEERING, Electro Chemistry*.

England

Note on Some Remains of Early Iron Manufacture in Staffordshire. Thomas Turner. Read before the Iron & Steel Inst. Notes on early iron work in England, analyzing the products and briefly reviewing the history. Ills. 2000 w. Engng—May 10, 1912. No. 32990 A.

India

Further Notes on the Early Use of Iron in India. H. G. Graves. Read before the Iron & Steel Inst. Describes the big iron beams found at Kanarak, the method of construction, etc. 2200 w. Engng—May 10, 1912. No. 32991 A.

Progress

Metallurgical Developments in Iron and Steel. John S. Unger. Read before the Am. Iron & Steel Inst. Considers recent changes in blast furnace and steel works practice. Short discussion. 3500 w. Ir Age—May 23, 1912. No. 33054 C.

Rolling Mills

The Operation of a Large Electrically Driven Reversing Rolling Mill. Wilfred Sykes. Illustrated description of the plant of the Illinois Steel Co., which has been in operation five years, and the results obtained. 4500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33242 F.

See also same heading, under *Copper*.

Roman Iron

Notes on a Bloom of Roman Iron Found at Corstopitum (Corbridge). Sir Hugh Bell. Read before the Iron & Steel Inst. Describes a large mass of wrought iron unearthed in England and explains what led to its discovery. Ills. 3000 w. Engng—May 10, 1912. No. 32989 A.

Steel

Steel. J. W. Richards. Reviews briefly the past and present meaning of the term. 1800 w. Met & Chem Engng—May, 1912. No. 32645 C.

The German Steel Syndicate: Details of the Statutes. A résumé of its statutes showing how the combination has been administered, and related information. 4000 w. Ir & Coal Trds Rev—April 19, 1912. No. 32459 A.

Heavy Steel Industry. Arthur Cooper. Presidential address to the Iron & Steel Inst., reviewing the development of the Bessemer and open-hearth processes and their modifications. 7000 w. Ir & Coal Trds Rev—May 10, 1912. No. 33013 A.

Steel Works

The Works of the Tata Iron and Steel Company, Limited. Data and illustrations of the steel plant at Sakchi, Bengal, India. 3000 w. Ir & Coal Trds Rev—May 3, 1912. No. 32879 A.

LEAD AND ZINC

Analyses

The Volatility of Zinc Oxide. O. L. Kowalke. Read before the Am. Elect-Chem Soc. Reports investigations, describing apparatus and procedure. 1200 w. Chem Engr—May, 1912. No. 33140 C.

Jigging

Joplin Jigging Practice. Claude T. Rice. Describes the practice. 1500 w. Eng & Min Jour—May 18, 1912. No. 32943.

Separation

Magnetic Separation of Zinc Iron Ores as Found in Southwestern Wisconsin. Otto E. Ruhoff. Describes laboratory tests to effect a separation without losing so much sulphur that the iron tailings are no longer of value to acid manufacturers. 3500 w. Met & Chem Engr—May, 1912. No. 32650 C.

Smelting

The Electric Zinc Smelting Furnace. Charles F. Johnson. Describes the Johnson process for making valueless ores available. Ills. 2500 w. Met & Chem Engr—May, 1912. No. 32651 C.

The Reduction of Blue Powder in Zinc Smelting. Warren F. Bleeker. Abstract of a paper before the Am. Elec.-Chem. Soc. Describes experiments carried out to solve the problem of reducing to spelter this powder. 2000 w. Min & Engng Wld—May 4, 1912. No. 32610.

MINING

Blasting

Methods of making a 220,000 Cu. Yd. Blast in a Sandstone Quarry. Plan and description of a blast in a quarry at Tenino, Washington. 1200 w. Engng & Con—May 8, 1912. No. 32652.

The Dangers of Accident in Blasting with Electric Ignition and Fuse Ignition (Die Unfallgefahr bei der Schiessarbeit mit elektrischer Zündung und mit Zündschnurzündung). O. Döbelstein. Investigations and tables on the ratio of accidents in both methods. 2000 w. Glückauf—April 13, 1912. No. 32704 D.

Compressed Air

Compressed Air Plant for Mines. Lucius J. Wightman. Discusses compressor units and transmission systems with a view to economy. 2000 w. Compressed Air—May, 1912. No. 33093.

Costs

Cost of Mining a Ton of Ore. Heath Steele. Considers the general average of low costs of mining is \$1.40 per ton. In case of large deposits the cost may be as low as \$1 per ton. 1400 w. Eng & Min Jour—May 25, 1912. No. 33081.

Diseases

The Causes and Prevention of Miners' Nystagmus. T. Lister Llewellyn. From *Pro. of the Royal Soc.* Describes this eye trouble and gives theories of its cause. 2500 w. Col Guard—May 10, 1912. Serial. 1st part. No. 32985 A.

Drilling

3-Ft. and 3-Ft. 6-In. Radial Drilling Machines. Illustrates and describes two types. 600 w. Engng—April 26, 1912. No. 32844 A.

Drills

Tempering Drill Steel. Clarence C. Semple. Discusses methods of tempering. 800 w. Eng & Min Jour—May 11, 1912. Serial. 1st part. No. 32941.

Notes on the Design of Drill Bits. Ward Blackburn. Considers cutting more important than staying qualities. 2000 w. Eng & Min Jour—May 11, 1912. No. 32806.

Electric Haulage

The Operation of Electric Ore Roads in Sweden. Oskar Gjessing. Map and illustrated description of lines electrified. 1800 w. Min & Engng Wld—May 25, 1912. No. 33147.

Electric Power

See Mine Power, under ELECTRICAL ENGINEERING, *Generating Stations.*

Explosives

The Behavior of Nitroglycerine When Heated. Walter O. Snelling and C. G. Storm. A report of investigations and results. Ills. 3000 w. U. S. Bureau of Mines, Tech. paper No. 12. No. 33174 N.

The Use of Permissible Explosives. J. J. Rutledge and Clarence Hall. Information intended primarily for coal miners, especially for those working when inflammable gas or coal dust may cause explosions. Ills. 34 pages. M S Bureau of Mines, Bul No. 10. No. 33173 N.

Gas-Engine Power

Gas-Engine Power at French Mines and Smelters. Stuart Rice. Illustrates and describes a number of installations made by French companies. 2200 w. Min & Engng Wld—May 4, 1912. No. 32609.

Hoisting

Mine Hoisting Systems Compared. Bruno V. Nordberg. A discussion of the factors governing the economy and efficiency of steam, air, and electric hoists. 4200 w. Eng & Min Jour—May 18, 1912. Serial. 1st part. No. 32945.

The Control of Electric Mine Hoists. S. Haar. Discusses rheostatic control and control by voltage variations. 3500 w. Gen Elec Rev—May, 1912. No. 33003 C.

The Ilgner System in Electric Hoisting Operations. George E. Edwards. Illustrates and describes the Leonard system of electric drive as modified by Charles Ilgner and applied to hoisting operations. 3000 w. Min & Engng Wld—May 11, 1912. No. 32819.

Hoisting Buckets

Gauging Hoisting Buckets in Mining Plants (Die Eichung der Fördergefäße im Bergwerksbetriebe). Herr Köbrich. Reviews of Prussian and Saxony laws governing the size and strength of mine buckets. 7000 w. Glückauf—April 27, 1912. No. 32740 D.

Hoisting Cables

Fault Location on Mining Cables. G. B. Burrows. Read before the N. of Eng. Branch of the Assn. of Min. Elec. Engrs. Illustrates methods of procedure recommended by the writer in cases of trouble on mains. 2500 w. Ir & Coal Trds Rev—May 3, 1912. No. 32896 A.

Hoisting Engines

Electric Driven Hoisting Engines by Continuous Current Motors with Leonard Regulations or Monophase Motors with Double Commutation (La Commande Electrique des Machines d'Extraction par Moteur Continu avec Réglage Léonard, ou par Moteur Monophasé à Double Collecteur). Discussion on the relative merits of the two systems. Ills. and plate. 5500 w. Génie Civil—April 27, 1912. No. 32778 D.

Laws

Canadian Coal-Mining Laws. Aims to give a complete list, so far as ascertainable. 2500 w. Col Guard—April 26, 1912. No. 32842 A.

The Prospector and the Mining Law. T. F. Van Wagenen. Discusses the ends to be secured in mining laws, with especial reference to inducements and protection. 3000 w. Min & Sci Pr—May 18, 1912. No. 33058.

Methods

The Miami, Okla., Mining Camp. C. H. Plumb. An account of early prospecting and mining methods at this lead and zinc camp. Map. 1200 w. Mines & Min—May, 1912. No. 32544 C.

Mexico

Conditions in Mexico. T. Lane Carter. Remarks on the political conditions and the effect on the mining industry. Map. 2200 w. Min Mag—May, 1912. No. 33100 B.

Mine Cars

Determination of Frictional Resistance of Mine Cars. G. W. Hamilton. Shows the importance of such information in connection with haulage problems, and explains methods of determining. 1500 w. Elec Jour—May, 1912. No. 33208.

Prospecting

Geology in the Examination of Prospects. C. A. Stewart. Shows the value of a knowledge of geology, discusses the classification of the deposit, secondary enrichment, etc. 2000 w. Min & Sci Pr—May 4, 1912. No. 32675.

Rock Breakers

Breaking Ground Without Powder. G. E. Wolcott. A proposed method of breaking ground by driving wedges into the rock by powerful machines of the air-hammer type. 1500 w. Eng & Min Jour—May 25, 1912. No. 33084.

Shafts

Reinforced Concrete as Applied to Mine Shafts. E. R. Jones. Abstract of paper before the Mich. College of Mines Club. Deals with the making and installation

of the concrete. 2500 w. Min & Engng Wld—May 25, 1912. No. 33149.

Timbering

Square-Set Mining at Vulcan Mines. Floyd L. Burr. Extracted from Pro. of L. Superior Min. Inst. Considers the adaptability of the system to mining ore bodies of irregular shapes. Ills. 2500 w. Mines & Min—May, 1912. No. 32542 C.

Methods for the Preservation of Mine Timbers. G. B. McDonald. From the Iowa Engr. Describes and discusses the preservative methods used. 3000 w. Min & Engng Wld—May 18, 1912. No. 32955.

MINOR MINERALS**Lithium**

Lithium: Occurrences, Chemistry, Extraction, Uses. Amil A. Anderson. Abstract from S. Dak. Sch. of Mines Qr. 2200 w. Min & Engng Wld—May 18, 1912. No. 32957.

Mica

Descriptive Mineralogy of Mica. Douglas B. Sterrett. Considers different varieties and the variations in structure that influence values. Ills. 2500 w. Mines & Min—May, 1912. No. 32543 C.

Natural Gas

Problems in Natural Gas Engineering. Thomas R. Weymouth. Considers some of the more important engineering problems and the methods of solution. 10000 w. Jour Am Soc of Mech Engrs—May, 1912. No. 33213 D.

Nickel

Determination of Carbon in Nickel (Bestimmung des Kohlenstoffs im Nickel). Max Orthey. Describes chemical test for making this determination. 2100 w. Giess Zeit—April 15, 1912. No. 32706 D.

Potash

The Searles Lake Potash Deposit. W. D. Hamman. Information concerning this deposit in California. 2500 w. Eng & Min Jour—May 18, 1912. No. 32942.

Tin

Geologic Features of Tin Deposits. H. G. Ferguson and A. M. Bateman. A summary of the geologic features of tin deposits, aiming to establish criteria which may prove of value to mining engineers and geologists. 11500 w. Ec-Geol—April-May, 1912. No. 33121 D.

Some Genetic Relations of Tin Deposits. Joseph T. Singewald, Jr. Discusses briefly some transitional occurrences of tin deposits, pointing out their genetic significance. 5500 w. Ec-Geol—April-May, 1912. No. 33122 D.

The Cornish Tin Ticketing. Harold E. Fern. A study of the method adopted by the chief producers of Cornwall for the sale of their tin concentrate. 2000 w. Min Mag—May, 1912. No. 33101 B.

The Disintegration or "Decay" of Metallic Tin. Ernst Cohen. Abstract of paper on the "Allotropy of Metals," read before the Faraday Soc. Describes the conditions and the causes of the change

in structure. Ills. 1200 w. *Mech Engr*—April 19, 1912. No. 32487 A.

ORE DRESSING AND CONCENTRATION

Agglomeration

Agglomeration of Fine Materials. Walter S. Landis. Lists the more important materials that have been agglomerated, and describes the processes used. 2500 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33229 F.

Briquetting

The Schumacher Briquetting Process. Joseph W. Richards. Explains the process and illustrates and describes the Brück-Kretschle mechanical press and a complete plant. General discussion. 3500 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33231 F.

The Briquetting of Iron-Ores. N. V. Hansell. Considers modern methods of agglomeration for utilizing waste products. Ills. 6500 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33232 F.

Sintering and Briquetting of Flue-Dust. Felix A. Vogel. Explains the conditions to be complied with to recover in the blast-furnace all the values represented by the material contained in the flue-dust, and the processes applied. General discussion. Ills. 3500 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33230 F.

Classifiers

The Roisin and Richard Picker and Classifier for Various Materials (*Trieur-Classeur pour Matières Diverses, System Ch. Roisin et J. Richard*). L. Pierre-Guedon. Details of this inclined screw-roll classifier. Ills. and plate. 1600 w. *Génie Civil*—May 18, 1912. No. 32787 D.

Concentrators

A Plant for the Enrichment of Pyritic Blende Concentrates. E. C. Hugon. Describes a plant recently erected in France for separating the pyrites from the blend concentrates. Ills. 3000 w. *Inst of Min & Mt*, *Bul*. 92—May 9, 1912. No. 32799 N.

Experimental Plant

The Experimental Ore Dressing and Metallurgical Plant of the Colorado School of Mines. Victor C. Alderson. Explains the need of such a plant and gives a detailed description of the building, equipment, and work. 4500 w. *Met & Chem Engng*—May, 1912. No. 32647 C.

Flotation Processes

Flotation of Minerals. Kenneth A. Mickle. Gives results of continued investigations upon differential gas and liquid attaching phenomena. 2000 w. *Aust Min Stand*—April 11, 1912. Serial. 1st part. No. 32998 B.

Gold Milling

Recent Experiments under the Head of Treatment for Gold-Bearing Ores. Especially Pyrites (*Neuere Versuche aus dem Gebiete der Aufbereitung goldhaltiger Erze, vornehmlich Pyrite*). Frd. Freise. Tests on roasting, cyanide, permanganate,

and the Sulman-Teed process of extraction. Serial. 1st part. 2400 w. *Oest Zeit f Berg u Hüttenwesen*—April 27, 1912. No. 32739 D.

Sintering

The Sintering of Fine Iron-Bearing Materials by the Dwight & Lloyd Process. B. G. Klugh. Discusses some of the technical details involved in the operation of the plant at Birdsboro, Pa., and of the theoretical and practical relations of this product to blast-furnace practice. Also discussion of methods. Ills. 7000 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33228 F.

See also Briquetting, under *Ore Dressing and Concentration*.

RARE MINERALS

Radium

The Origin of Radium. Frederick Soddy. From a discourse delivered at the Royal Inst. Reports results of experimental study. 3000 w. *Nature*—April 25, 1912. No. 32999 A.

MISCELLANY

Canada

Annual Report on the Mineral Production of Canada. John McLeish. Report for the year 1910. 328 pages. *Can Dept of Mines*, No. 143. No. 33180 N.

Metallurgy

The Crystalline Constitution of Metals. Thomas A. Eastick. Discusses the influence of annealing on crystalline structure. Ills. 1500 w. *Sci Am Sup*—May 4, 1912. No. 32578.

Ore Deposits

The Geology and Ore Deposits of the Silver Bell Mining District, Arizona. C. A. Stewart. Describes the location, topography, geology, the rocks and their alteration, ore deposits, etc. Ills. 14500 w. *Bul Am Inst of Min Engrs*—May, 1912. No. 33227 F.

Notes on the Geology of the Mina Mexico Vein. Dibrell P. Hynes. Gives the location of the property, its geology, etc. The minerals of the vein are pyrite, quartz, blende, galena, calcite, and tetrahedrite. 2000 w. *Ec-Geol*—April-May, 1912. No. 33123 D.

Two Phases in the Genesis of Ore Deposits. G. W. Miller. Discusses underground solutions and their value as ore carriers, and the evidences supporting such conclusions. 3500 w. *Min & Engng Wld*—May 25, 1912. Serial. 1st part. No. 33150.

Reports

Illogical Precision in Mine Reports. F. Percy Rolfe. Considers the expressing large tonnages to the accuracy of a single ton, and reporting assays to excessive minuteness to be inconsistent, and that the results can be better expressed by approximations in round figures. 3000 w. *Inst of Min & Met*, *Bul* 92—May 9, 1912. No. 32797 N.

CONDUCTING TRANSPORTATION

Accidents

Railroad Wrecks. D. F. Jurgensen. Considers steps that should be taken to decrease the number of preventable accidents. 4500 w. Jour Assn of Engng Socs—April, 1912. No. 33114 C.

Operation

Government Railway Operation in France. Paul Leroy Beaulieu. Trans. from *The Economist*. An account of the deplorable condition. 2500 w. Ry Age Gaz—May 10, 1912. No. 32695.

How an Engineering Contractor Would Run a Railroad. A. P. Greensfelder. Address. 14500 w. Pro St Louis Ry Club. April 12, 1912. No. 32189.

Signalling

Block Signal Mileage, January 1, 1912. Information from the bulletin of the Interstate Commerce Commission showing the mileage of railways in the United States with block system. 2500 w. Ry Age Gaz—May 10, 1912. No. 32694.

MOTIVE POWER AND EQUIPMENT

Accelerometers

A Direct Reading Accelerometer. Illustration and brief description of an instrument which reads acceleration and transition curve defects. 300 w. Sci Am Sup—May 4, 1912. No. 32579.

Air Brakes

I. Brake Valve and Pipe Connections. II. Broken Air Pipes with L. T. Brake. Gives view of the straight air brake valve of the L. T. equipment, and discusses methods of temporary arrangement for bringing in a train with broken air pipe. Ills. 2000 w. Ry & Loc Engng—May, 1912. No. 32531 C.

A Recent System of Continuous Braking for Freight Trains (Nouveau Système de Freinage Continue des Trains de marchandises). M. V. Sabouret. Description of system, its advantages, applications, some trials of a recent air-brake. Ills. 12000 w. Mem Soc Ing Air de France—Feb., 1912. No. 32750 G.

Braking

Passenger Train Braking. Considers passenger car brakes, with reference to the "L. N." and "P. C." type. 2200 w. Ry & Loc Engng—May, 1912. No. 32532 C.

Locomotive Fuel

Locomotive Fuel. A chapter from a forthcoming book. Deals with the subject of compound and single expansion engines from the basis of economic results. 1500 w. Ry & Engng Rev—May 18, 1912. Serial. 1st part. No. 32958.

Locomotives

Remarkable Locomotives of 1911. J. F. Cairns. Illustrates notable designs. 400 w. Cassier's Mag—May, 1912. No. 33026 B.

The Great Western Locomotive "Great Bear." Detailed drawings and descrip-

tion of six-coupled express engine. 5000 w. Engr, Lond—May 3, 1912. No. 32889 A.

Tank Locomotive for the County Donegal Railways Joint Committee. Illustrations and particulars. 300 w. Ry Gaz, Lond—April 26, 1912. No. 32835 A.

Largest Non-Articulated Locomotive. Illustrated detailed description of a new C. B. & Q engine having a tractive effort of 71,500 lbs., obtained with one group of drives and two simple cylinders. 2000 w. Ry Age Gaz—May 3, 1912. No. 32575.

Four-Coupled (4-4-2 Type) Tank Locomotive, North British Railway. Plate illustrations and note of one of thirty passenger engines for service on short distance express trains to the Coast and elsewhere. 150 w. Engng—May 3, 1912. No. 32884 A.

4-Ft. 3-In. Eight-Coupled Side Track Shunting Engine, L. & N. W. R. Illustrations with brief note. 100 w. Ry Gaz, Lond—May 3, 1912. No. 32877 A.

2-10-2 Type of Locomotive for the Chicago, Burlington & Quincy. Illustrated description of the largest engines ever built with all the driving wheels coupled in one group. 2200 w. Ry & Loc Engng—May, 1912. No. 32530 C.

Pacific Type Locomotives for the Chicago & Eastern Illinois R. R. Illustrated description. 800 w. Ry & Engng Rev—May 4, 1912. No. 32604.

Locomotive Valves

The Upkeep of Piston Valves on the Locomotives of the Compagnie de l'Est (L'Entretien des Tiroirs Cylindriques des Locomotives de la Compagnie de l'Est). M. E. Bernard. Discussion of methods and costs. Ills. 6050 w. Rev Gen des Chemins de Fer—May, 1912. No. 32757 G.

Motor Cars

Motor Railway Inspection Car. Illustrated description of a petrol-motor coach for the North-Eastern Ry. 700 w. Engr, Lond—May 10, 1912. No. 32995 A.

Rolling Stock

Non-Parallel Axle Rolling Stock. Illustrated study of the non-parallel axle trucks of the Metropolitan Ry of Paris. 1800 w. Engr, Lond—April 19, 1912. No. 32466 A.

Shops

Construction Features of the Water-vliet Shops of the Delaware & Hudson Company. O. D. Lee. Illustrated description. 4500 w. Cassier's Mag—May, 1912. No. 33031 B.

Woodworking Shops of the Hocking Valley Railway. Illustrates and describes an electrically operated plant used in maintenance of wooden cars. 2000 w. Wood Craft—May, 1912. No. 32600.

Train Lighting

Electric Lighting of Railway Trains: The Brake Vehicle Method. Roger

We supply copies of these articles. See page 663. Order by title and number.

Thomas Smith. With an abstract of discussion. Reviews the history of electric lighting of trains in England, and describes the system in use on the Great Western Ry. Diagrams. 102 pages. Inst of Civ Engrs, No. 3938—May, 1912. No. 33169 N.

Wheels

Has the Cast-Iron Wheel Reached Its Limit of Usefulness? W. J. Morrison. An address indicating that there are no reasons for believing chilled iron wheels have reached their limitations. Discussion. 6000 w. Pro So & S-W Ry Club—March, 1912. No. 33188 C.

Mixtures for Chilled Car Wheels. Gives comparisons showing the longer life of old-time charcoal product. Ills. 3500 w. Ir Age—May 16, 1912. No. 32899 C.

NEW PROJECTS

Florida East Coast Ry.

The Florida East Coast Extensions. Frank M. Patterson. Gives the history of the Key West project, details of novel and difficult construction, and discusses operating prospects. Ills. 4500 w. Ry Age Gaz—May 10, 1912. No. 32693.

Hudson Bay Project

The Hudson Bay Railway Project and the "Titanic" Disaster. Calls attention to the risks attendant on this enterprise, and the dangers of navigation on the proposed route. Map. Extract from official report to the Canadian government. 4500 w. Eng News—May 2, 1912. No. 32569.

PERMANENT WAY AND BUILDINGS

Construction

A Method of Dealing with a Railway-Cutting in Bog. George Hemingway Mills. A short account of new work as carried out in Ireland, so as to secure a safe roadbed. Ill. 1800 w. Inst of Civ Engrs, No. 3965 — May, 1912. No. 33167 N.

Drainage

Heavy Drainage Work on the Pennsylvania Railroad Near Petersburg, Pa. An account of difficulties encountered at Neff's Cut, Pa., and the remedies applied, with cost. Ills. 1000 w. Ry Age Gaz—May 17, 1912. No. 32925.

Grade Crossings

Grade Elimination and Bridges. Henry Grattan Tyrrell. Illustrates and describes methods of track elevation and bridges at street crossings. 2000 w. Can Engr—May 23, 1912. No. 33141.

Grade Separation at Grand Crossing. Illustrates and describes complicated construction work in connection with track elevation and subway work in Chicago. 3000 w. Ry Age Gaz—May 3, 1912. No. 32572.

Maintenance

Actual Economy in Railway Maintenance. R. P. Black. Gives suggestions from practice found to be economical in the maintenance of turnouts over which

the traffic is chiefly heavy tonnage freight trains. 1500 w. Ry Age Gaz—May 17, 1912. No. 32923.

Efficiency in Track Maintenance. C. E. Lindsay. Discusses Methods of accounting. 1800 w. Ry Age Gaz—May 17, 1912. No. 32924.

The Organization of the Extra Gang. Contributions received in a prize contest, discussing methods of successfully handling heavy maintenance work, with editorial note. 6000 w. Ry Age Gaz—May 17, 1912. No. 32922.

Rails

Rails Broken by Flat Wheels. Editorial discussion, referring to article by C. H. Benjamin and to the discussion. 1500 w. Ry Age Gaz—May 10, 1912. No. 32692.

Study of a Broken Rail on the New Haven. Illustrated description of the rail structure and conditions. 1200 w. Ry Age Gaz—May 3, 1912. No. 32576.

Roadbed

Embankments and Foundations. A. C. Oxley. Read before the Can. Soc. of Civ. Engrs. Describes the construction of roadbed from Bolton to Byng Inlet. Ills. 2500 w. Can Engr—May 9, 1912. No. 32818.

Stations

The Best and Most Economical Methods of Handling a Station. E. H. Campbell. Read at meeting of the Chicago Great Western Station Agents' Assn. Explains the value of system, considering some details. 4500 w. Ry Age Gaz—May 24, 1912. No. 33071.

Terminals

New Locomotive Terminal at Carbondale. Illustrated description of the D. & H.'s improved facilities for taking care of Mallet locomotives used in heavy coal movement. 600 w. Ry Age Gaz—May 17, 1912. No. 32921.

TRAFFIC

Interchange

Freight Interchange at Chicago. Outlines the present facilities and methods and describes two plans proposed to effect savings in time and cost. Map. 3500 w. Eng News—May 9, 1912. No. 32691.

Private Railways

Decision in Tap Line Cases. Decision of the Interstate Commerce Commission indicating rules for determining what lumber roads should be considered as being plant facilities. 5500 w. Ry Age Gaz—May 3, 1912. No. 32573.

MISCELLANY

Brazil

The Railways of Brazil (Les Chemins de Fer du Brésil). A. Le Vergnier. Brief review of the several systems in Brazil, and their sources of revenue. Map. 4800 w. Génie Civil—May 18, 1912. No. 32788 D.

Management

See same heading, under INDUSTRIAL ECONOMY.

STREET AND ELECTRIC RAILWAYS

Cars

Novel Departure in Tramcar Design. Illustrated description of the stepless cars being introduced in New York City. 2200 w. Tram & Ry Wld—May 9, 1912. No. 33012 B.

Construction

Foreign Street Railway Construction. Illustrated review of details of foreign practice. 8000 w. Eng News—May 23, 1912. No. 33065.

Europe

Some Impressions of the Electric Traction Situation in Europe. C. E. Eveleth. Explains differences in requirements in Europe and America, and reviews impressions in different countries. 4000 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33250 F.

Interurban

The Operation of Limited Trains on Short Interurban Lines. P. P. Crafts. Read at Iowa Convention. Suggestions for service on interurban lines, giving results obtained. 2000 w. Elec Ry Jour—May 4, 1912. No. 32636.

Locomotives

The Electric Locomotive. C. E. Barry. Explains the advantages claimed for electric locomotives, and reviews briefly the four distinct systems of power distribution employed in the United States, and their bearing on locomotive design. Ills. 2500 w. Sib Jour of Engng—May, 1912. No. 33203 C.

Thirty-Ton Electric Locomotive for the Frederick Railroad, Frederick, Maryland. Illustrated description. 800 w. Mach (Ry Ed)—May, 1912. No. 32640 C.

Single-Phase Locomotives for the Prussian State Railways. Illustrated description of the electric locomotives for the Dessau-Bitterfeld Ry. and their operation. 3000 w. Engr, Lond—April 26, 1912. No. 32851 A.

Locomotive Tests

Freight Train Tests on an Electric Interurban Railway. S. T. Dodd. Discusses a series of tests made upon electric locomotives pulling freight trains on the Fort Dodge, Des Moines & So. Ry., and a tabulation of results. Ills. 3500 w. Pro Am Inst of Elec Engrs—May, 1912. No. 33252 F.

Power Stations

Georgetown Power Station of the Capital Traction Company. Illustrated description of this plant on the Potomac River. 2500 w. Elec Ry Jour—May 4, 1912. No. 32635.

Rail Corrugations

Corrugation of Rails. J. H. Briggs. Describes experiments made to ascertain

whether the friction which results from the forced skid of a leading outer wheel could also bring about a periodic action. 3000 w. Elect'n, Lond—April 26, 1912. Serial. 1st part. No. 32832 A.

Re-equipment

Re-equipment of the Fort Dodge, Des Moines & Southern for 1,200-Volt Operation. This steam road was equipped in 1906 for handling passengers by 600-volt trolley. It has recently been re-equipped for handling both freight and passengers by 1,200-volt trolley. Ills. 4500 w. Elec Ry Jour—May 18, 1912. No. 32950.

Repairs

Tools for Electric Railway Repairs. C. A. Tupper. Outlines the scope of repair work and illustrates and describes some required tools. 2000 w. Am Mach—May 16, 1912. No. 32867.

Single-Phase

Single-Phase Railways. Illustrated description of the overhead equipment of the Dessau-Bitterfeld Ry. is given in the present number. 2500 w. Engr, Lond—May 3, 1912. Serial. 1st part. No. 32886 A.

The New York, Westchester & Boston Railway. Map and illustrated account of the franchise history of this new single-phase suburban railway, the territory it serves, relation to established lines, the service it gives, etc. 3500 w. Elec Ry Jour—May 25, 1912. No. 33146.

Subway Lighting

See Illumination, under ELECTRICAL ENGINEERING, *Lighting*.

Subways

Use of Concrete in the Fourth Avenue Subway of the New York Underground Rapid Transit Railway System. From a paper by Frederick E. Noble, read before the Nat. Assn. of Cement Users. Illustrates and describes interesting features of work in Brooklyn. 2500 w. Engng & Con—May 1, 1912. No. 32557.

Constructing the Lexington Avenue Subway. Methods of excavating, timbering and underpinning. Ills. 1800 w. Eng Rec—May 4, 1912. No. 32587.

The Cambridge Subway. Illustrated description of the characteristics and equipment of the latest addition to the rapid transit system of the Boston Elevated Ry. Co. 4500 w. Elec Ry Jour—May 11, 1912. No. 32815.

The Recent Flood in the New Subway of Berlin. Illustrated account of a serious accident in the section under construction under the Spree River, which admits the water to the completed and operated section also. 1600 w. Sci Am Sup—May 4, 1912. No. 32580.

We supply copies of these articles. See page 663. Order by title and number.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; H, of \$1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m*. Brussels.
American Architects. *w*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brickbuilder. *m*. Boston.
Builder. *w*. London.
Bull. Bur. of Standards. *qr*. Washington.
Bulletin de la Société d'Encouragement. *m*. Paris.

Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. of Can. Min. Inst. *qr*. Montreal.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m*
Liège.
Bull. Tech. de la Suisse Romande. *s-m*. Lausanne.
Bull. Univ. of Illinois, Urbana, Ill.
Bureau of Mines, Washington.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Cassier's Magazine. *m*. New York and London.
Castings. *m*. Cleveland, O.
Cement. *m*. New York.
Cement Age. *m*. New York.
Chemical Engineer. *m*. Chicago.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Commercial Vehicle. *m*. New York.

- Compressed Air. *m.* New York.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering and Contracting. *w.* Chicago.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Turin.
 Industria. *w.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal N. E. Water Works Assn. *qr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-g.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Journal Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of England. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 La Nature. *w.* Paris.
 Le Yacht. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Métallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining and Engineering World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Moniteur Industrielle. *w.* Paris.
 Monitore Tecnico. *tr-m.* Milan.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *qr.* Philadelphia.
 Pro. Engineers Society of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Quarry. *m.* London.
 Queensland Government Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Locomotive Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Génie des Chemins de Fer. *m.* Paris.
 Revue Génie des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific American Supplement. *w.* New York.
 Sibley Journal of Mech. Eng. *m.* Ithaca, N. Y.
 Société Belge des Electriciens. *m.* Brussels.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.



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No. 5

IRON-ORE RESERVES

By Edwin C. Eckel

In an advance announcement of Mr. Eckel's articles made editorially last month, we pointed out their active and immediate interest in connection with the conclusions reached and recommendations made by the Committee of the House of Representatives under the chairmanship of Mr. Stanley.

The sections of that report relative to the ownership of raw materials and its effect on the progress and control of the steel industry are of particular interest, as bringing up questions which have not yet received legal attention in the United States, and concerning which neither the law nor the facts seem to be generally understood.

These are the fundamental questions in the case, and we have welcomed as a contribution of great value this digest of facts and probabilities by a leading authority on the subject. Mr. Eckel's relations are frankly stated in his opening paragraphs. His reading of facts does not deprive him of opinions. But his articles are not published here as an editorial argument—nor indeed as an argument of any kind—but as a well-informed professional opinion on certain phases of a very important case which should be decided in the forum of public opinion by careful examination of all the testimony. It carries the weight of its author's own qualifications.—THE EDITORS.

THE present series of articles will discuss certain phases of the iron-ore-reserve problem, in both its industrial and political relations. These will include consideration of the manner in which the American ore reserves are now held, and of the factors which limit the extent of control; estimates of the total extent of the American and tributary reserves, and of the probable future demands upon them; and determination of the elements involved in the valuation of such reserves.

It will be seen that the questions involved are of immediate interest

and of great importance, not only to the iron industry, but to all American industrial development. The formulation of a proper public policy for dealing with control of raw materials and other natural resources must be preceded by careful study of all the factors which are concerned in the matter. If we are to retain our present system of entirely private control of such matters, the present status must be justified by proving that it is both equitable and efficient. For if it can be proven that private ownership leads to either injustice or inefficiency, some form of Government regulation will ulti-

mately result. In either case the policy adopted, to be of permanent value, should be based upon the facts of the case, and not be accepted merely because it happens to fit in with what seems to be the political or business requirements of the hour.

It is hardly necessary to recall that two very detailed investigations of the American steel industry have recently been made, by a Congressional Committee and by the Bureau of Corporations respectively; or that a suit for the dissolution of the United States Steel Corporation is now pending in the courts. On a later page, however, attention will be called to a less widely advertised case already decided—that against the Aluminum Company of America—which presents many features of interest in the present connection. The fact that these various investigations and suits have been prosecuted during the past few years is of advantage to a certain extent, for they have furnished a large selection of views and data from which to quote. But on the other hand it involves the very serious disadvantage that the writer, in suggesting that one view of a controverted question seems more reasonable than another, may be considered to have the fate of one particular corporation in mind, and to be arguing the case as a partisan instead of stating the facts and probabilities fairly. This difficulty may as well be recognized frankly, and the only possible reply to such criticism is to offer the discussion itself in proof, and to submit that it does not bear evidence of having been treated in a partisan spirit. As a matter of fact it may be noted that much of the data here presented had been prepared for use, in another form, some time before politicians discovered that iron ore could

be made to yield publicity as well as metal.

I. THE ELEMENT OF MONOPOLY

In a later section, where discussion of the ore reserves of the United States is taken up, it will be pointed out that until 1906 or thereabouts no one was particularly interested one way or another in the total quantity, probable duration, or ownership of our iron-ore reserves. It was known, of course, that some individuals and corporations owned more ore, or better ore, than others; but it was commonly assumed that this was due either to good fortune or to the exercise of better business judgment. It seems fair to say that, up to then, no one considered that there was anything unjust, either to competitors or to the public, in these conditions. The possibility that any one individual or corporation had secured or could secure ownership of all the iron ores of the country, or of any dangerous proportion of those ores, was not even dreamed of.

STAGES IN THE EVOLUTION OF OPINION

In 1906, however, an extremely pessimistic foreign estimate of America's ore resources reached the public eye, and became of interest in connection with an already well-formulated "Conservation Movement." This resulted in a second stage of public opinion regarding iron-ore supplies and their ownership.

The Conservation Viewpoint.

In order properly to understand the situation at this stage, it must be recalled that the conservation movement, at its inception and for some time after, was not concerned with the ownership of our various natural resources, but with their waste and exhaustion. Reasoning from conditions which undoubtedly existed in the lumber industry, it was per-

haps too hastily assumed that a careful study of mining conditions would show that vast quantities of valuable minerals were being left in the mines or otherwise wasted. Soon after this, however, this idea was further developed into the view that, whatever might be the actual situation with regard to mining wastes, there was also need for careful study of the actual extent of some of the more important mineral supplies. Accordingly it was decided to secure as close an estimate as possible of the total available American reserves of iron and certain other metallic ores, of coal, oil and gas, and of phosphate rock. The reason for this particular selection of subjects will probably always remain a mystery, but the list omitted a number of mineral products whose supply is apparently limited, and on the other hand included some of unquestioned abundance.

This investigation of mineral resources was carried out by geologists detailed from the United States Geological Survey, and reports on the results of their work were later published by that organization. The work on iron ores had been placed in charge of Dr. C. W. Hayes, then chief geologist of the Survey, and his report is a sane and valuable contribution to the literature of the subject, which will be discussed in some detail in a later article of this series. So far as we are here concerned with the matter, the Hayes report may be summarized as stating (1) That there is no serious avoidable waste in iron mining; (2) that the immediately available iron ores of the United States, of present commercial grade, aggregate almost five thousand million tons; (3) that, in addition, there are about seventy-five thousand million tons of ore, of lower grade or more poorly located,

which will gradually become available as the better ores become exhausted; and (4) that certain reserves of high-grade ore, aggregating several thousand million tons, located in Cuba, Canada, and Newfoundland, must logically be considered a portion of the immediately available American reserve, since they can be used most economically and profitably in the United States.

Impossibility of Actual Monopoly.

It will later be pointed out that both our own immediately available reserves and the ore reserves in commercially tributary territory are in fact much larger than the Hayes report would imply. In any casual discussion of the matter it will be safe to assume that the available American reserve amounts to at least six or seven thousand million tons; and that the tributary tonnage is approximately as large.

At intervals there has been a good deal of rather indefinite talk about the existence or possibility of absolute monopoly in ore ownership. Consideration of the tonnages involved in the problem, as briefly stated above, will serve to show the great practical difficulties which would prevent the formation of an absolute monopoly, even were there no competitive purchasers or legal prohibitions to hinder attempts in this direction. At present, therefore, both the possibilities and the actual conditions in this line should be fairly well understood, and it is not probable that anyone who has paid much attention to the subject takes the possibility of absolute monopoly very seriously.

As to existing conditions, some idea can be gained by considering that even the largest existing steel company has not advanced very far in the direction of ore control. Estimates based on the official reports

of the Minnesota and Michigan Tax Commissions credit the United States Steel Corporation with owning approximately half of the Lake ore reserves. In the South its holdings are far smaller, both relatively and absolutely, amounting probably to one-fifth or less of the total southern reserve; while in the western and northeastern ore districts it does not appear as an ore owner. For the entire United States, therefore, its proportion drops to perhaps one-quarter of the total; and if Cuba be included, to a far smaller fraction. As a matter of fact, the Pennsylvania Railroad Company, through its control of the Pennsylvania and Cambria Steel companies, is a very close second to the Steel Corporation in the matter of total ore tonnage owned, and far exceeds it if total ownership be compared with actual annual requirements. Many of the smaller companies have, in similar fashion, acquired far heavier ore holdings than the Steel Corporation, relative to their needs.

From any point of view, however, it is obvious enough that actual monopoly does not exist, and that it is not even dangerously approached. It will be later seen that, entirely irrespective of legal conditions, there are good business reasons for not attempting to secure it.

Present Status of the Discussion.

With the passing of the idea that it would be either feasible or profitable for one company to secure control of all, or almost all, of the American reserve of iron ore, the ground of discussion has been shifted. This shift has been so gradual, however, that even in discussing the subject we are hardly aware of the change. We still speak casually of attempted or threatened monopolies in ore holdings, while as a matter of fact

we are really dealing with something quite different, and the arguments which would support or refute the old charges as to monopoly are valueless in treating the present phase of the discussion.

Under these circumstances, it is desirable to consider some of the points which are now brought into the field. In doing this it will be absolutely necessary to take cognizance of the various investigations which the United States Steel Corporation has undergone, at the hands of Government bureaus and Congressional committees, for in the course of these investigations all possible phases of the question have, at one time or another, been brought into view. It will not be necessary, however, to limit the present study to that particular corporation, for in order to be of any real value the conclusions reached must be of general application. Since practically all of the iron and steel manufacturing companies of the United States have followed the same general methods as regards acquisition, ownership, and valuation of ore reserves, it is possible to carry out this discussion without narrowing its scope to an individual instance.

Recent Views on Ore Ownership.

During recent years most of the opinions expressed on this subject have been by lawyers or politicians, rather than by engineers or manufacturers. It is obvious enough that this situation is not likely to result in a careful and impartial consideration of a rather complex technical problem, for neither the legal nor the political habit of mind is adapted to secure an adequate and fair presentation of a matter involving close reasoning from engineering and financial data. The acutely logical mind of the lawyer is often engaged

in working over a mass of very doubtful data, while the politician too often regards neither basal data nor logic.

The result is, that in discussing this subject, we have to deal with an extensive and variable mass of argument and opinion relative to ore ownership, some of which is distinctly worthy of attention, while much more can not be taken very seriously. In considering this great variety of opinion, selection of the views which seem to be important enough to justify further discussion is, of course, largely a matter of personal judgment. The principal views which have been seriously advanced within the past five or six years, regarding the monopolistic ownership or use of iron ore reserves, seem to be those which may be briefly summarized as follows:

(1). That ownership of ore mines by steel companies is an abnormal and comparatively recent condition; and that the public interest would be best served if an absolutely independent set of mine-owners sold ore to a distinct set of furnacemen.

(2). That, though actual monopoly does not exist, some or all of the larger steel companies hold greater ore reserves than are demanded or justified by their actual requirements, as indicated by their present annual consumption of ore.

(3). That, though actual monopoly does not exist, there are not sufficient ore lands remaining in independent hands to permit the formation of a large new steel-manufacturing company.

(4). That, regardless of extent of ownership, the steel companies are in a position to earn excessive profits on their finished steel, because of assumed excessive valuations placed on their ore reserves.

In glancing over this group of summarized opinions, the reader will immediately note that, whatever their individual value, they are to some extent mutually contradictory. It would be difficult, for example, to accept simultaneously conclusions 1 and 4, for obviously the excessive valuations assumed in 4 would be more than counterbalanced by the new set of intermediate profits which would be introduced if 1 were accepted and followed. Similar contradictions occur elsewhere in the series, when the various arguments and views are critically examined, but in spite of this certain recent reports have managed to accept the entire series simultaneously.

Accepting the four views above summarized as representing, for the moment at least, the most widely published opinions in criticism of the present status of ore ownership, it will be of interest to discuss in some detail the general principles by which the validity of the different views must be tested. It will be found, curiously enough, that many points which are commonly thought to be mere matters of opinion can, in reality, be determined with mathematical accuracy.

Of the four opinions cited, the first and second will be considered in the present article, as being most closely related to the question of monopoly. The third can be most conveniently treated later, in connection with a discussion of the total ore resources of the United States; while the fourth falls naturally in with the subject of ore-reserve valuation.

THE FUNDAMENTAL QUESTION OF OWNERSHIP

Relation of Mine and Furnace.

The view first cited brings us face to face with the broadest

and most fundamental criticism that can possibly be brought against the existing status of ore ownership. It is of importance, not because of its inherent strength and soundness, but because of its basal character, and because of the dangerous remedies which it invokes.

This view, briefly stated, is that any ownership of ore mines or lands by iron or steel manufacturers is abnormal, and contrary to good public policy. It involves, as will be seen, a question of historic fact and a question of future policy. Taking up the first phase of the matter, it is notable that during some of the recent discussions of the steel industry, there became evident a curious misconception of the relations which have normally existed in the past between iron-ore mines and blast furnaces. The Chairman of the Stanley Committee, for example, frequently framed questions on the obvious assumption that ownership of mines by furnace interests dated back only to the advent of the large steel combinations—say to 1900 or thereabout. It was evidently taken for granted by Mr. Stanley, as well as by some of his associates on the committee, that during all the earlier periods of the history of the American iron industry, furnace owners ordinarily bought their ore from an entirely independent set of mine owners. This erroneous assumption, unimportant in itself because it relates to a matter of purely historic interest, becomes of great importance as the argument is followed out, for it is used as a basis for conclusions of immediate and serious import. Assuming that ore ownership by furnace interests is a recent development in the industry, the conclusion drawn is that such ownership, in its present stage, is a step in the direction of final ore monopoly.

As a matter of historic fact, the assumption that mine and furnace have normally been separate enterprises could hardly be further from the truth. During all of the earlier periods of American iron history, the furnace owned and operated the mine, and was ordinarily located near it. In the south, east and west this business relation between the two has persisted uninterruptedly until the present day, so that over the greater portion of the United States merchant ore mines have never been of great importance. The Champlain and imported ores hardly qualify this statement.

In the Lake Superior district, however, there was a relatively short period when the independent ore mine was the most important factor in the industry. This condition arose gradually, was due to peculiar local conditions, and seems to be passing. Since the conditions which caused it have disappeared, the merchant mine is apparently on the way to becoming as scarce in the Lake region as it has always been elsewhere in the country.

At the commencement of mining in the Lake Superior iron district, the merchant mine was not contemplated, for all of the earlier enterprises were planned with the idea of making charcoal iron in the Lake region itself. Later, when the ore began to be shipped east, it is noteworthy that the very first shipments were to a furnace whose owners promptly secured the mine and commenced direct operation. As the mining area extended, however, and the older iron-producing centers became more and more dependent upon the Lake district for their ore supplies, the independent or merchant mine became a prominent factor in the industry, and remained so for thirty years or more. The eastern furnace-

men, confident that all their annual ore requirements could readily be filled in the open market, put their spare capital or new capital into additional smelting and finishing plants, as promising more immediate and larger profits than investments in mining lands.

Throughout all this period, however, there had always been mines operated directly by furnace interests, or controlled by them; and each period of depression in the iron business tended to decrease the relative importance of the merchant mines. In the eighties and early nineties this process became more marked, and long before the so-called "Trusts" were formed most of the larger iron and steel-manufacturing companies had mining interests in the Lake region. There is little to indicate that the later formation of the great industrial combinations had much effect, one way or the other, on the decline in merchant mining. It was, after all, merely a return to the conditions which had always existed in the other American iron-mining regions.

Effect of Independent Operation.

Nothing further need be said concerning the historical side of the matter, on which fortunately the record is sufficiently clear and decisive. Some consideration must be given, however, to the industrial features of the problem, in an attempt to determine, so far as possible, what form of mine ownership is likely to result in the maximum of economy and efficiency.

At present we are concerned chiefly in comparing the results attainable under independent or merchant ownership with those reached when the mines are controlled by the iron and steel companies directly. It must not be overlooked, however, that a third possibility is either

openly or implicitly put forward by some critics of the existing status. For the logical result of overthrowing this status would be, not to increase the importance of the merchant mine, but to introduce some form of Government regulation or operation. We may reasonably look forward to meeting, in the near future, arguments in favor of one of the following alternatives: (1) Government ownership of ore lands; (2) Government ownership and operation of sufficient mines and reserves to control the market; or (3) some form of Government regulation of ore prices. These possibilities may sound unreasonable, but they follow logically enough from a conclusion that operation of mines by steel companies is either inefficient or inequitable.

As to the facts in the case, direct evidence is difficult, and we can only judge from the comparative results attained in the past, at different mines and in different regions, under the two methods of operation. From this basis, the following conclusions seem to be justified;

(1) If all the iron and steel companies bought ore from independent mines in the open market, the fluctuations in ore prices would be wider than under present conditions. In prosperous years the mines would demand prices greater than they can now secure; in poor years they would sell ore at the cost of mining, without allowance for depreciation or amortization.

(2) Over a long series of years, including the usual proportion of good and bad periods, the price of ore would average notably higher than at present, for the mines when conducted as independent enterprises would expect a higher rate of profit than they are now credited with.

(3) So far as technical efficiency is concerned, that would not suffer if all of the mines, though independent of the steel companies, were in the hands of two or three large mining companies. But if the ownership of the mines were widely scattered, so that a number of relatively small mining companies existed, we might expect a marked decrease in efficiency. One result would be, almost certainly, that only high-grade ore would be shipped so long as it could be secured. This would cause an increase in the percentage of waste, and a shortening of the life of the ore reserves.

From the standpoint of either industrial efficiency or of the public interest, there seems therefore to be little to justify the criticism that independent ownership and operation of the mines would yield better results than are secured now.

THE LIMITATIONS OF RESERVE OWNERSHIP

The question next to be considered is whether the iron and steel companies have secured ore reserves so far in excess of their requirements as to justify the suspicion that the purchases were really monopolistic in intent, if not in effect. It is obvious that in order to settle this question it is first necessary to decide what the actual requirements of a modern steel company are, in the line of ore reserves. It will be found, on examination, that both their minimum requirements and their allowable maximum reserves are fixed by business considerations; and that both are clearly definable.

Minimum Permissible Reserves. Taking up first the ore requirements of a modern steel company, it is to be noted that the *minimum* ore reserve which a steel-manufacturing company can safely carry is deter-

mined, and determined within rather close limits, by the amount of its investment in manufacturing plant and other fixed property. It would be obviously injudicious to risk a heavy investment which might be made entirely valueless within a few years by a shortage in ore supply. To be in a sound financial position, a steel company must therefore own sufficient ore to justify the erection of a steel plant of commercially competitive size, and to guarantee that this plant will be able to remain in operation on a competitive basis for a long period of years.

The length of the period whose ore supply should be made certain may, in fact, be fixed with some approach to accuracy. A modern steel company, making its own pig-iron and steel, and selling a varied line of finished products, will necessarily have invested in plant and other fixed property somewhere in the neighborhood of forty to sixty dollars per ton of steel annually sold. These figures seem to be within the limits of the data presented recently in a report of the Bureau of Corporations, which certainly did not err in the direction of over-capitalization, and they may therefore be accepted as close to the possible *minimum* investment for which such a plant could be put together.

We may therefore assume that the average plant investment, excluding ore lands and working capital, is fifty dollars per ton of annual product. It is clear that if the profitable life of this plant is limited by the duration of its ore supply, a short-lived ore supply will necessarily mean that a heavy allowance must be made each year to cover the ultimate scrapping of the plant. However this allowance may be handled in an accounting sense, it will in fact be a direct addition to

the cost of producing each ton of steel. Disregarding for the moment the effect of interest charges to this account, it is roughly accurate to say that if the ore supply is only sufficient to last ten years, it adds five dollars per ton to the cost of producing steel; if the ore supply will last twenty-five years, this additional charge will be only two dollars per ton; if the ore will last fifty years, one dollar per ton of finished product will cover the final scrapping loss.

In reality, each of these figures would be decreased somewhat by interest credited to the sinking fund, but that fact does not seriously alter their relative importance, or affect the bearing of the present argument.

Industrially, it is evident that, other things being equal and merchant ore unobtainable, the relative duration of their two ore reserves will determine the competitive status of two steel companies. A company which must charge off five dollars per ton of steel in order to provide against a short-lived ore supply can not hope to compete with a rival whose charge to this account is only one dollar per ton.

It is obvious that there is a practical limit to the utility of this line of reasoning. The difference in the sinking-fund charge per ton decreases rapidly as the duration of the ore supply increases, and after a time becomes practically negligible. Taking this into account, it might perhaps be said that a modern steel company can hardly afford to have less than a twenty-five year supply of ore; that a larger supply would be even more economical; but that after a fifty or sixty year supply is secured the economy due to still longer life becomes too small to be important commercially.

Maximum Advisable Reserve.

It has been seen that the minimum ore reserve which a steel company can safely and economically provide is fixed, within quite definite limits, by purely business considerations. It is equally true, though it seems to be less commonly understood, that the maximum reserve which it is economical or advisable for a company to own is also fixed by business considerations. That is to say, whatever the state of the law or of public sentiment on the subject, there is a point beyond which it is not *profitable* to go, in the way of owning large ore supplies. This point is fixed by the rapidity with which carrying charges—interest, taxes, etc.—accumulate on ore which is not used within a reasonable number of years after its purchase.

At this point it is necessary to call attention to the differences introduced by variations in the original cost of the ores. Obviously the carrying charges on a hundred-year supply of cheaply acquired ores will be less than on an equal supply of more expensive ores; but the full effect of this factor is rarely comprehended. If we recall that the average holdings of Lake Superior or northeastern ores may have cost the companies from twenty to fifty cents or more per ton, in the ground, while the average Cuban or southern ore reserve has perhaps cost from one-tenth of a cent to two or three cents per ton, it will be seen that the difference in carrying cost must be enormous. The result of this is that it is economically possible to carry far larger reserves of Cuban or southern ores than of the more expensive northern ores.

Data on Actual Reserves.

The following table presents specific data relative to some points which have just been discussed in a gen-

eral way. In it will be found the total reserve-ore tonnage of a number of typical American iron and steel companies, and the present annual rate of ore consumption of these same companies. From these two sets of figures it is of course a mere matter of arithmetic to determine the approximate length of life of the ore reserve of each company, provided its average annual requirements do not increase. This they are of course likely to do, but we may for our present purposes assume that all of the companies will grow at about the same rate, so that the figures in the last column are in any case strictly comparable.

figure from an appraisal report. The Pennsylvania and Bethlehem data are from semi-official notices regarding the Cuban lands of the two companies. The Woodward figure is submitted by the present writer, and is close enough for our present use. Taken as a whole, these estimates of reserve tonnage may be accepted as being fair, impartial, and as accurate as possible.

When the figures in the subjoined table are examined, and compared with the requirements as calculated in preceding sections, it will be seen that there is little reason to believe monopolistic intent has had much influence on ore-reserve purchases.

ORE HOLDINGS AND CONSUMPTION OF STEEL COMPANIES

Company	Ore District	Tonnage owned	Present annual draft	Duration of supply
United States Steel Corp.	Lake district.....	900,000,000	21,000,000	43 yrs.
United States Steel Corp.	Lake and Alabama	1,300,000,000	23,000,000	55 yrs.
Pennsylvania Steel Co....	Cuba alone.....	600,000,000	934,092	642 yrs.
Republic Iron & Steel Co.	Alabama	89,000,000	700,000	127 yrs.
Republic Iron & Steel Co.	Lake and Alabama	128,000,000	2,000,000	64 yrs.
Bethlehem Steel Co.....	Cuba alone.....	250,000,000	318,814	783 yrs.
Sloss-Sheffield Co.....	Alabama	78,000,000	800,000	95 yrs.
Woodward Iron Co.....	Alabama red ores.	235,000,000	500,000	450 yrs.

With regard to the sources of the data used, it may be said that the annual consumption given is either the exact or the approximate tonnage taken out during 1910, a record-breaking year so far as ore-shipments were concerned. The reserve tonnages for the Steel Corporation in the Lake district are based on those reported by the Minnesota and Michigan Tax Commissions; while its Alabama reserve (400,000,000 tons) is taken from reports by a number of engineers. The Republic reserves are quoted from annual reports of that company; and the Sloss

The companies whose chief holdings are in the Lake Superior district have really rather scanty reserves there. They would probably be glad to increase their holdings, but present prices for Lake ores in the ground are high, and the carrying charges would be heavy. The companies which have secured reserves in the south or in Cuba, where ore lands are still incomparably cheaper than in the Lake region, are subject to lighter carrying charges, and can therefore take on far heavier reserves without entering upon policies of doubtful economy.

(To be continued)

THE WORKS OF THE ENGINEER AND THE WORLD'S PEACE

By George Duncan Snyder

It is often observed that engineering has not fully taken its place on the same plane with the other learned professions. The engineer's advice is too frequently neither asked nor given with the same recognition of authority that is granted the physician or the lawyer, though his science and its data are far more exact. The cause may be partly in the engineer's failure to assert the dignity of his calling. Mr. Snyder's article shows a fine realization of the work of the engineer and its meaning for humanity, and such views and their declaration should help to inspire a truer appreciation both in and of the profession of engineering.—THE EDITORS.

IT is gratifying to the engineer to consider that his art, which was first developed as a branch of the art of war, has become one of the active agencies of peace. The very name "engineer" until a century ago meant military engineer, and when Shakespeare wrote of the engineer being hoist with his own petard, this was its only meaning, and an engine then meant a military machine of destruction. When a word was required to describe the builder of the numerous works necessary to the development of the world, such as roads, canals, bridges and the like, the prefix "civil" was inserted and the modern words civil engineer were created to differentiate the peaceful from the warlike branches of the art. It will thus be seen that civil engineering is the offspring of military engineering, and, like a dutiful child, is proud of its ancestry and antecedents, and is glad to acknowledge the debt it owes its parent.

While in ancient times many beautiful and useful works were constructed, many of which are standing unto this day, which the modern engineer would be proud to have constructed, yet those built solely for beauty or religion were more the work of the artist, the architect, or

the clergy, those for a useful purpose were more the work of a superior class of artisans or craftsmen than of the engineer, and engineering as a science and art was first developed by the soldier. The reason it developed from the military engineer rather than from the architect is that the civil engineer had more in common with the former than the latter on account of the eminently practical and utilitarian character of his work.

The first schools where engineering could be studied in a scientific way were military schools; the first school where it was taught in this country was the United States Military Academy at West Point, and many of our earlier public works were constructed by men trained in this admirable institution as soldiers, leaving the army to engage in civil work. While it is no longer necessary to attend the Military Academy to obtain schooling in engineering, many excellent technical schools existing throughout the land, the country is still indebted to this institution for the engineers who are directing much of its civil engineering work. The United States Government's river and harbor work is executed in an able, efficient, and honest way by our army engineers, after a trial of

several civil engineers in charge of the herculean task of building the Panama Canal, a military engineer has been detailed to this work, and he is quickly and ably bringing it to a successful conclusion. It will thus be seen that the basic principles of the two branches of the profession must be closely allied and that they differ only in their application of varying ends.

The work of the military engineer is to build walls and fortifications in his own country and to destroy such works in the enemy's; to build and defend his own communications and to destroy and obstruct the enemy's. His work is, therefore, largely obstructive, destructive—to interfere with the ease of communication—while that of the civil engineer is constructive, to remove or pierce obstructions and to facilitate communication.

Civil engineering is, therefore, considering its warlike antecedents, a clear case of beating swords into plow-shares and spears into pruning hooks.

In the Royal Charter of the Institution of Civil Engineers of Great Britain, which may be called the parent engineering society of the world, civil engineering is defined as "the art of directing the great sources of power in nature for the use and convenience of man." This definition thus covers a broad field and includes architects, mechanical and electrical engineers, as well as many scientists and inventors who would not claim to be engineers, and, in fact, all engineering not military which may be directed to the construction of tools, machines or ways which can be converted to man's use or convenience, and not for his inconvenience, obstruction or destruction.

The history of the world is one long catalogue of wars and battles,

and we find but little change in this respect for century after century until we come to the last one hundred years, when we observe with the end of the Napoleonic wars a sudden change in their number and frequency. What is the reason for this?

Did human nature suddenly change; did man suddenly grow tired of war; did his moral sense suddenly develop; and did wars become less frequent because man thought that it was wrong; or did he cease making war because it no longer paid? What is the reason that after a score of centuries of almost constant war we have had a century of almost constant peace? If we search history can we find the answer?

Students of history may be divided into two general classes: those whose tendency it is to attribute events to moral, intellectual and spiritual movements, and those who look for underlying causes in physical or material facts. Thus in the crusades the one sees only a great moral and religious movement, and the other as an underlying force the ambition of the prince for new empire and the desire of the merchant to extend his commerce. The one sees the reformation as a religious movement only; the other finds secular and political forces predominating. The one sees in the civil war between the States a great moral movement on the part of the North to compel the South to cease to maintain an immoral institution; the other sees nothing moral in the fact that the North did not keep slaves and desired to prevent the South from doing so, but attributes the underlying motives to economic conditions, and holds that the North kept no slaves because they did not pay in that climate, and that its desire to abolish the institution in the South was because the paid

labor of the North could not compete with the free labor of the South.

In the past century which has witnessed this great diminution in the frequency of wars, has occurred the greatest development in civilization the world has ever known, and in it in particular has occurred the creation and development of the art of the civil engineer. To what elements in this development can we attribute this sudden change in the frequency of wars? Is it due to moral or intellectual forces or to material ones?

While the intellectual movement has been great and there has been a great diffusion of knowledge throughout all classes, it seems doubtful if this is the cause as there have been great intellectual movements before without this result, and whatever effect this higher level of intelligence has had, it could not have been brought about without the works of the engineer. The engineer in his work has to deal with tangible elements and is, therefore, accustomed to attain his ideals by material forces, and looks for tangible facts as the cause of events. The cause to which he would attribute this condition is, therefore, the increased ease of transportation and communication as brought about by the steam engine, the printing press, and the telegraph, and the consequent stimulus to commerce and the internationalization of capital.

The Napoleonic wars ended in 1815, and while Watts' improvements to the steam engine were patented in 1769, this device was not extensively used until early in the nineteenth century. The first steamship crossed the Atlantic in 1819, and regular steamship lines were inaugurated in 1838. The first successful application of steam to railroad transportation was in 1829. While

the printing press had been invented in the fifteenth century, it did not become an efficient tool for the rapid circulation of information among the masses until it was operated by power, as a hand press could make but 250 impressions on one side of a sheet per hour. In 1814 the first power press was used by the *London Times*, capable of making 1,100 impressions per hour, from which the wonderful capacity of modern presses has developed. This was followed by the first commercial telegraph line in 1843 and the trans-Atlantic cable in 1865. These epoch-making inventions could not fail to have a far-reaching effect on the commercial organization of the world, as before their creation each nation was more or less self-contained, producing practically all the necessities of life within its own borders, and while commerce existed, it was more or less in the luxuries or non-essentials of life.

Of the above inventions the most far-reaching in its effects is the steam engine. In its application to railway and ocean transportation and to manufacturing, it has revolutionized commerce, as it furnishes the means of bringing the raw materials from the uttermost parts of the earth to manufacturing centres; of making the finished articles, and then distributing them to the consumer the world over. It is, therefore, the father of modern commerce, and by providing power to the printing press and transportation to its output, it shares with the telegraph the parentage of modern journalism, and it is to these modern means of transportation and communication that the engineer would attribute this change in the belligerent attitude of nations.

The railway, the steamship, the telegraph, the printing press, and

the ship canal, have made the world smaller and have directed the thought of the inhabitants into the same channels, and commerce and travel are obliterating national and racial prejudices.

Can we say then that the change in the past hundred years has been caused directly by spiritual forces or indirectly by material forces? The intellectual movement towards peace has not been strong or active until the past ten years, while the material movement has been advancing steadily and uniformly and has brought strong influences to bear on the lives of all.

What of the future? Can universal peace be brought about by treaties, international agreements, arbitration courts only, and can national armies and navies be disbanded as useless? Without disparaging the good effect of these agencies, too much should not be expected from them as long as they do not possess the power to enforce their decrees, as long as the contracting nations continue their armament as before, and as long as the nations can abrogate the treaties on which these agencies are based. The infrequency of war in the past century has been brought about by a development of natural material force, and if universal peace is to come in the future, it will be by the continual development of these forces.

In the past one hundred years but one serious conflict has occurred in the highly civilized and highly developed portion of Europe, and most wars have been confined to portions of the world under development and being opened to civilization.

It is not likely that without the railway, the steamship, the telegraph, and the printing press, the continental area of the United States could have developed into one homo-

geneous nation with practically the same ideals and aspirations from the Atlantic to the Pacific and from the Great Lakes to the Rio Grande. This nation was almost wrecked at the start by jealousies and differences due to the isolation of the several States. The one great conflict between the North and the South was brought about by different economic conditions which prevented the homogeneity of the nation and which mattered little as long as the parts were more or less isolated; but when the works of the engineer commenced to develop the country into one unit by railways, steamship lines, and internal commerce, it was felt that these different conditions could not continue and the irrepressible conflict occurred. At that time a goodly number of our citizens held their allegiance to their States more sacred than that due the nation. Today these conditions are reversed and national ties are stronger than State, and what has brought this about but the improved means of transportation and communication which have fused the diverse elements of our population into one nation and one race? This is a case where the works of the engineer hastened war, but brought lasting and permanent peace. Applying this to a larger field, can we not look for these same agencies gradually to lessen national ties and foster a feeling of international brotherhood?

Looking the world over, we find unstable and warlike conditions prevail where the means of transportation and communication are the least developed—in China, part of Africa, and much of South and Central America. The original colonists of North America were not as homogeneous in character as those in South America; yet the former developed into two stable governments while the

latter separated into a dozen or more separate and more or less unstable nations. What but the works of the engineer on the one hand and the lack of them on the other, brought this about?

With these material forces continuing to develop the world, the various parts thereof will soon be of equal accessibility, which will make stability of government possible, and with the engineer, the capitalist, the manufacturer, and the merchant working together, international commerce will follow and such an interdependence of the different nations of the world will occur that war may so unbalance relations that it would become intolerable.

The spiritual and intellectual forces have had great influence on the history of the world, but do not exert themselves with the same intensity at all times; while a line of communication between two countries, a bridge crossing a frontier river, a tunnel piercing a mountain boundry, a steamship line connecting distant countries, and the telegraph cable, are permanent arguments acting with increasing intensity as the commerce and inter-communication and intercourse develop with time.

Africa, Asia, and South and Central America will soon be covered with a network of railways; these works of the engineer will cause still further development and investment of capital, commerce will bring these inaccessible countries into close international relations with the family of nations, and stable conditions will prevail. But until human nature changes, peaceful conditions cannot be maintained without the use of force, and the cause of permanent and lasting peace suffers by talk of reliance on treaties and arbitration courts maintaining permanent peace without material means to enforce

it. The material development of the world works in two ways toward this end; first by tending to remove narrow racial prejudices; and, second, by enabling force to be used when necessary quickly, promptly, and efficiently.

The effect of the works of civilization in modifying racial prejudice acts quickly in the newer portions of the world and very slowly in the older centres of civilization where the inherited animosities and prejudices are very slow in dying out; but even here there are signs that ease of communication, international investments, and commerce, are bringing about improved conditions.

It has been proposed to connect England and France by a railway tunnel across the Channel, which would be a powerful incentive toward universal peace. The capitalist stands ready to risk his money, the engineer to risk his reputation; but England refuses to grant her consent for the fear of invasion from the continent, although in a few years England and France will be able to celebrate a century of peace. England's military and naval authorities oppose this project, but is not the military engineer belittling his art when he will not assert his ability to defend any means of communication that his civil brother can create?

Wealthy men have endowed peace prizes and peace funds and the influence of these are great, but has not the influence of the development of the world by the works of the engineer been greater, and is it not likely to continue to be greater?

Therefore, the engineer's peace monuments are enduring works of communication; his peace arguments are inventions in the mechanical arts, the steam engine, the telegraph, and the like; and he feels that an in-

vention that would improve the quality of steel rails, or reduce their price, is a more lasting peace force than a great sum of money.

It has become the fashion for persons of education, culture and refinement to deplore the materialism and commercialism of the modern world, but it would seem that these much derided agencies are not without their good influences and are indirectly doing more to make the world one community and to bring about the brotherhood of man and a realization of the dream of universal peace, than all other agencies combined.

Cheap and rapid transportation will surely in time make famine in one part with superabundance in another impossible, will tend to a more even distribution of the world's inhabitants and wealth, a lessening of national ties and an increasing of the feeling of citizenship of the

world, a lessening of self-contained communities and an increased mutual reliance between nations for the necessities and luxuries of life, and an increased realization of the brotherhood of man.

The engineer has no quarrel with the peace movement as he feels that his works are indirectly a great force working toward the same end, but the public should not delude themselves into thinking that the ideal condition of peace, prosperity and plenty can be achieved or maintained without the employment of material force, and the engineer militant and the engineer civil will be needed in the future as now; the one to build works to restrain man from himself, and the other to fight the unending battle against nature by directing the great source of power that nature itself has provided to make the world a harmonious and convenient habitation for its children.



POWER MACHINERY OF THE STEEL INDUSTRY

By Robert L. Streeter

Professor Streeter's series begun in this issue will be a sort of specialized extension of the survey presented in his articles on the Machinery of the American Steel Industry published in *THE ENGINEERING MAGAZINE* last summer. It might define the present study better to call it the counterpart of that preceding. It completes the view by showing the subject from the other side—from the driving rather than from the driven end. It focusses attention upon the motive power rather than upon the machinery that is operated.

The articles, which will be about six in number, will afford a profusely illustrated review of steam, electric and gas motors applied to the operation of American furnaces and mills. They will cover ore-mine hoisting machinery, coke-oven machinery, blast-furnace power, rolling-mill engines, general power units and electric generators and motors.—THE EDITORS.

THE iron production of the United States for the last ten years has averaged about 22,500,000 long tons per year, at the present time being about 25,000,000 tons. A large part of this iron, more than 90 per cent, is used in the manufacture of steel from which are made rails, structural shapes, plates, bars, bolts and hundreds of other products used daily in the industrial world. The ores produced to make this quantity of iron amounts to about 52,000,000 long tons per year.

The advance of the steel industry has not been of slow and conservative growth, such as takes place in many industries, but rather it has been rapid and spectacular, urged forward by men who lived for their work and labored many hours a day without thought of comfort or reward.

The Bessemer process of making steel was introduced into the United States about 1864. Up to that time, and in fact for some years after, wrought iron was used wherever steel is now used. The production of wrought iron is necessarily a slow hand-process not suitable for use where the output is large. When

steel did finally take the place of wrought iron, the necessity of using machinery instead of hand processes became apparent early. Thus large-capacity mills soon became a reality, and after the use of steel became thoroughly rooted, the ingenuity of the steel makers was turned in the direction of increased output. This increased output meant that almost every hand manipulation must be replaced by machine work, until finally our millions of tons of steel are now produced by a process in which the use of machinery has been so highly developed that manual labor is seldom, if ever, used in handling the product.

To furnish power to drive the steel-making machinery we find some of the best examples of the manufacturer's art, not in steam machinery alone but also in machines operated by electricity, gas, air, or hydraulic power. The development of this power machinery has usually followed the demand. Steel-plant engineers have always been reluctant to experiment, but have clung to machines whose worth had been proven, until the demand for increased output necessitated a change. Often, however, a new process re-

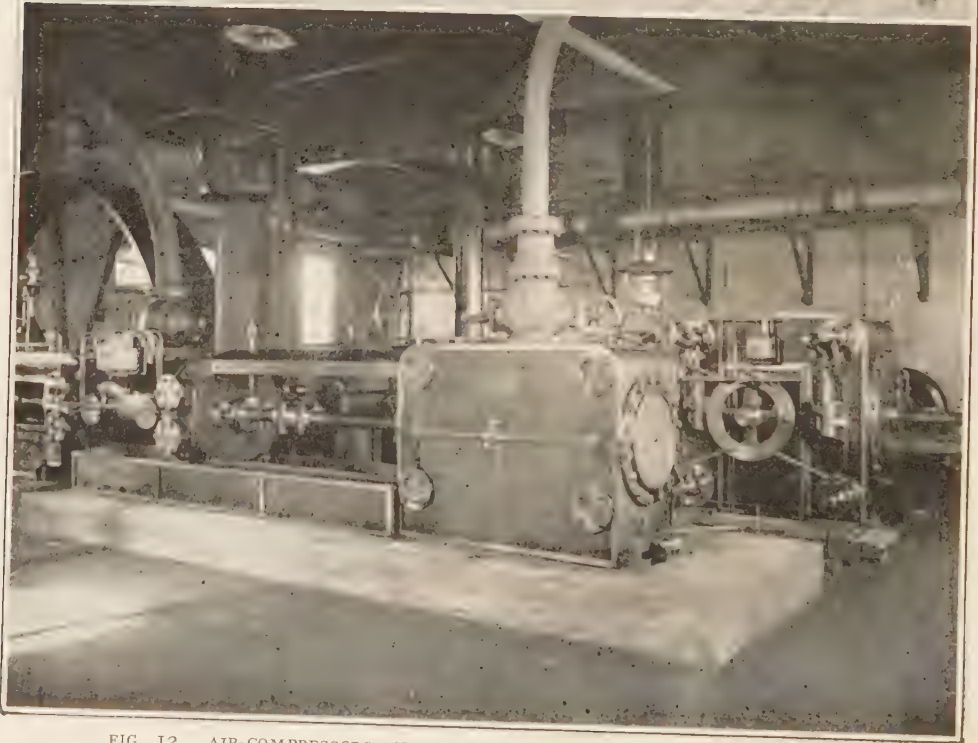
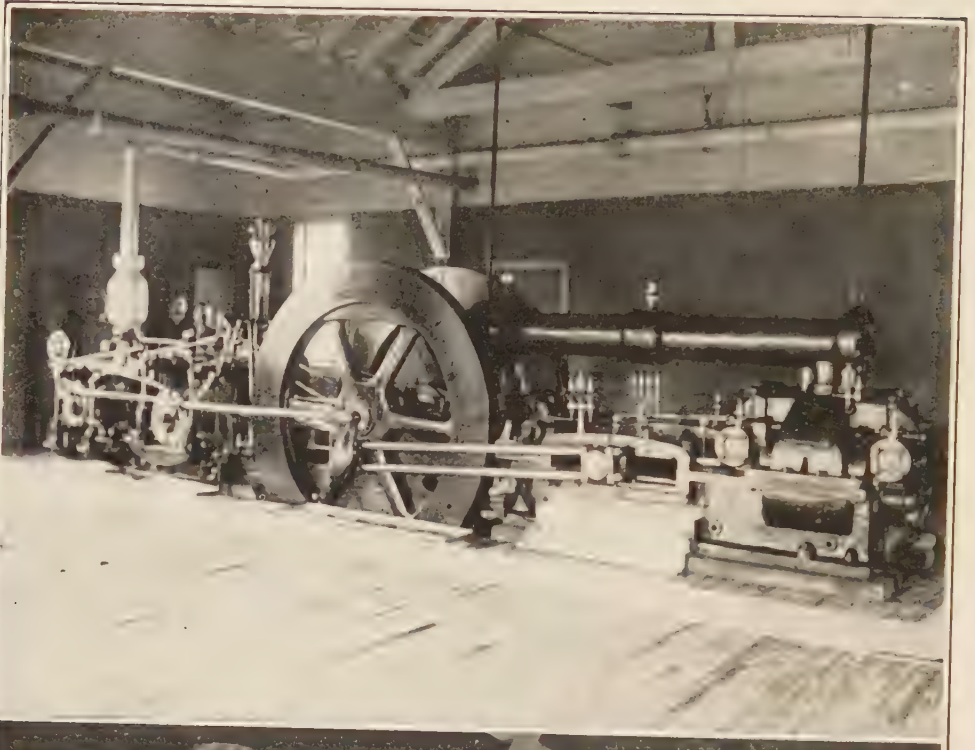


FIG. 12. AIR-COMPRESSORS IN AMERICAN IRON-MINING INSTALLATIONS
 Above, tandem two-stage compressor, capacity 1,380 cu. ft. of free air per minute, Buckeye Mine of Commonwealth Iron Co., Commonwealth, Wis. Below, a cross-compound compressor.
 Both by the Sullivan Machinery Co.

quires new power machinery and the success or failure of that process is sometimes wholly dependent on that machinery. The rapidity with which steel ingots or billets are charged into and drawn from heating furnaces of the present steel mill is a good example of what efficient power machinery may do in the economical handling of great quantities of material. The large rail mill of the Indiana Steel Company, turning out 3,500 tons of rails in twenty-four hours, would be an impossibility if the old steam hoisting engines had to be used instead of the finest type of electric pit cranes to take the ingots from the furnaces. Those high-speed rolling mills require feeding rolls that are rapid in manipulation and reliable in action, a combination secured in the heavy reversible electric motor. The engineer who designed those mills probably gave only a thought to the selection of these motors, for they have been tried and found to be perfectly satisfactory, but let us see what thought has been given to the same problem by men who have had to take the initiative as new and untried conditions came up:*

"The next and most important thing to make the blooming mill a grand success was a plan to convey power to the rollers that would permit raising and lowering of the tables and would at the same time drive them at any and all points within the travel of the table. The device must be simple, automatic and effective. . . . Many plans to get over this trouble were suggested and thought over, but all were complicated, and would surely be difficult to keep in order—something that must be avoided. At this stage things looked as if there was trouble

ahead and some thing had to be done, mechanically or otherwise.

"I now took into consideration that the variation in the distance between the driving and the driven points was short, say about eight feet, and I at once concluded to put a pulley on the engine shaft and one on the horizontal shaft on the table which drove the rollers, and put a tightener on the belt to keep it uniformly taut. The arrangement was so complete and so satisfactory that I felt somewhat abashed to think I had spent so much time over what seemed to be such a difficult problem and yet in the end was perfectly simple."

How out of place those belt-driven rollers would be on a modern mill, but what a step forward they were at that time! To such men as Mr. Fritz is due any honor and reward that can be given them for their superb work while the steel industry was yet young.

The use of efficient power machinery is general throughout all the stages of steel manufacture. With increased output of the steel rolling mills and decreased cost of rolling, the demand for ore in large quantities became urgent. Consequently we may expect to find just as high-grade machinery in the ore mines as in any department of the whole steel-making system. Power in large quantities is used in three places in the ore mine; for mining machines or drills, for mine locomotives, and for hoisting, and may be either steam, electricity, air, or hydraulic power. The most completely equipped mines are those in the Superior region, but not all well equipped mines are found there. Certainly the largest power units are located there, for those mines furnish the bulk of the ore used in the steel industries of the United States today. There are ten mines in the country

*Autobiography of John Fritz. Description of blooming mill designed and built by Mr. Fritz at Bethlehem in 1872.

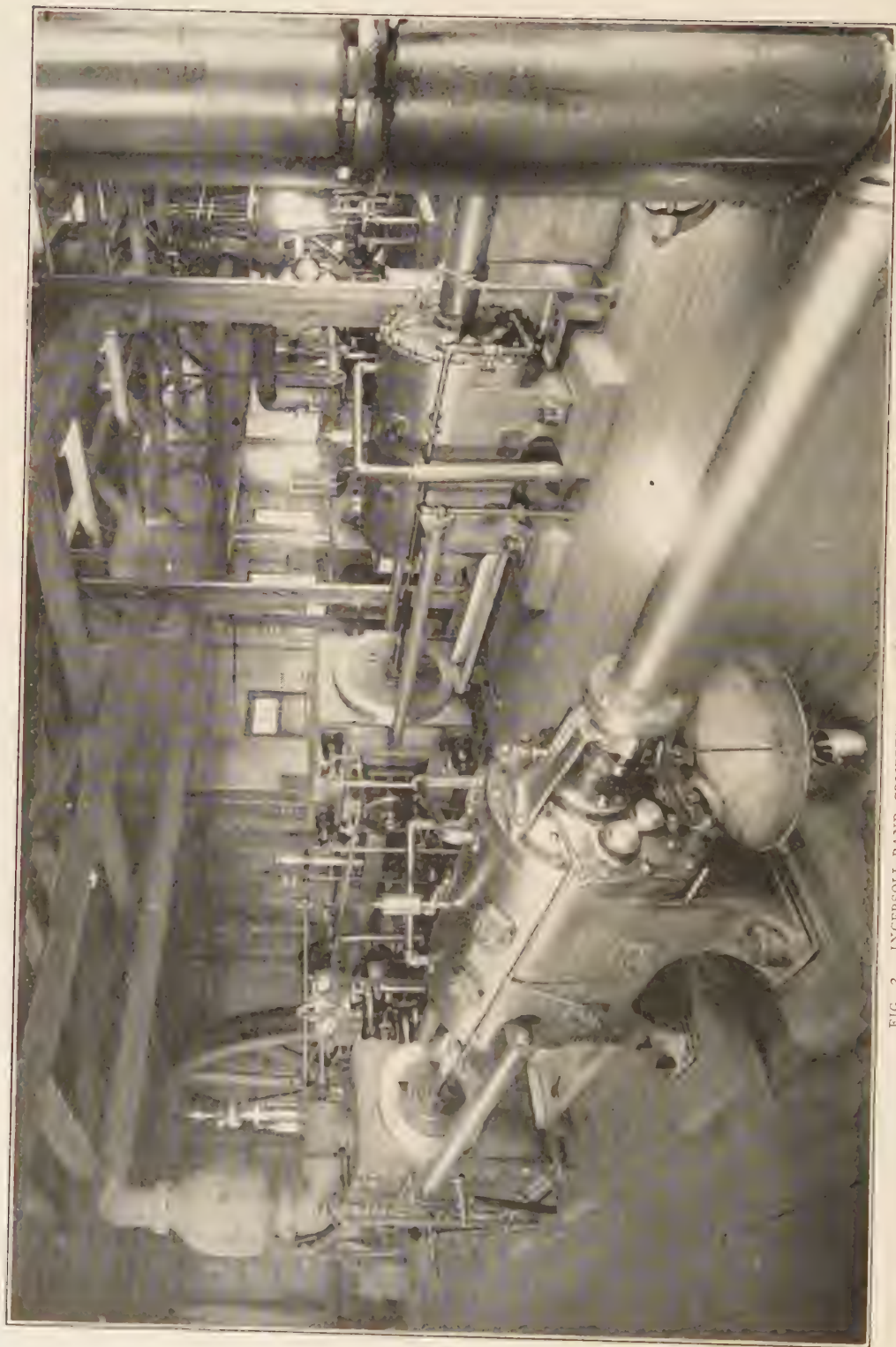


FIG. 3. INGERSOLL-RAND COMPRESSOR, PENN. MINING CO., AVONDALE, MICHIGAN

that produce more than one million tons a year each; nine of these are in Minnesota, the other in Alabama.

Compressed air is used for mining machines, drills, etc., and for locomotives in some mines. The compressors are run either by steam or electricity, by steam where no water power is available, but by electricity where one central station supplies

two steam and two air, are placed tandem. This arrangement minimizes floor space but at the same time makes very heavy flywheels necessary.

The cross-compound compressor shown in Figure 2 has steam cylinders 24 and 46 inches diameter and air cylinders 40 and 24 inches diameter with 48-inch stroke. This com-

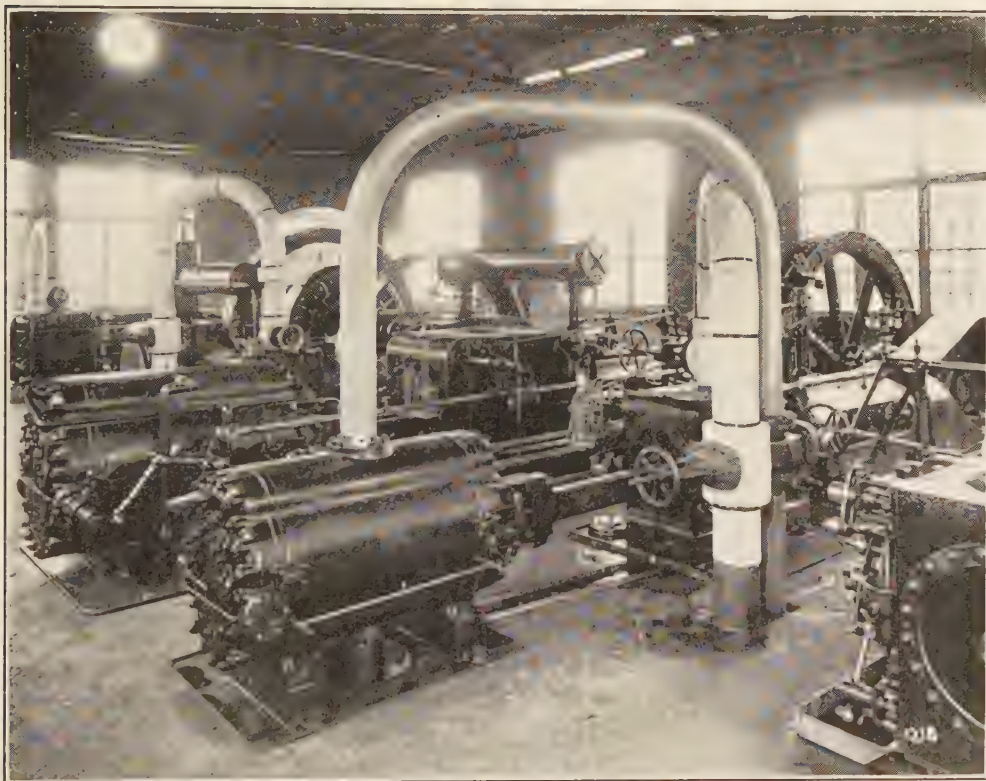


FIG. 4. COMPOUND CORLISS TWO-STAGE COMPRESSOR, MESTA MACHINE CO.

several mines. The central station may be either steam or water power.

When steam compressors are used, the Corliss type of steam cylinder is usually installed as the coal cost in the iron regions is usually high and great economy in the use of steam is necessary. The steam cylinders are also compounded to reduce further the steam consumption, and the air is compressed in two stages, to a pressure of about 100 pounds for drills, etc. In one type the four cylinders,

pressor, which is located at the Ne-gaunee Mine of the Cleveland-Cliffs Iron Company, was built to run by steam, but provision was made for changing it to an electrical-ly driven compressor by means of rope drive. The grooved fly-wheel may be seen on the main shaft, also the coupling where the piston rod will be disconnected when the steam cylinders are removed. To facilitate the making of this change, the steam cylinders were

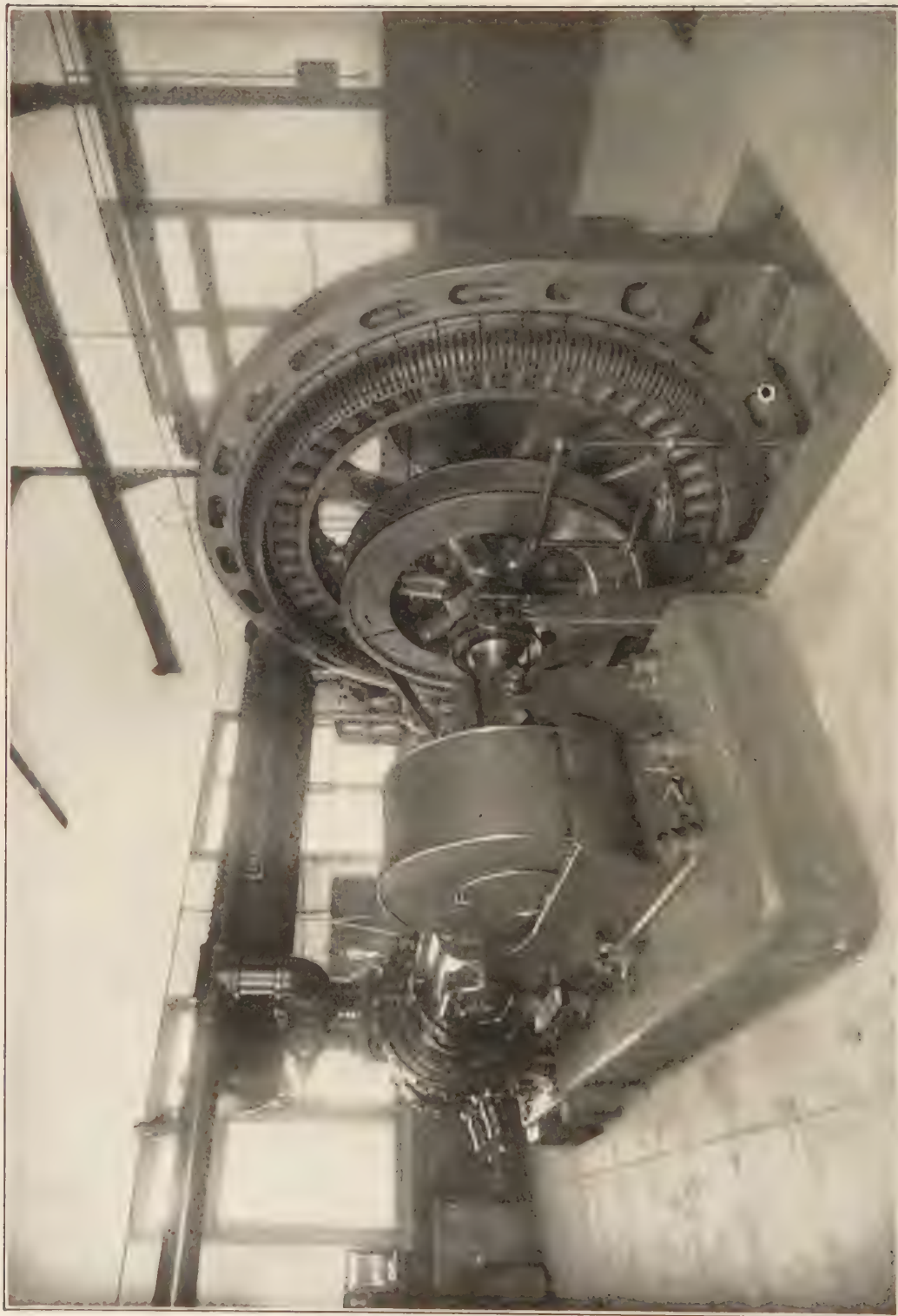


FIG. 5 TWO-STAGE COMPRESSOR DRIVEN BY THE TO ALTERNATING CURRENT MOTOR
Ingersoll Rand Co.

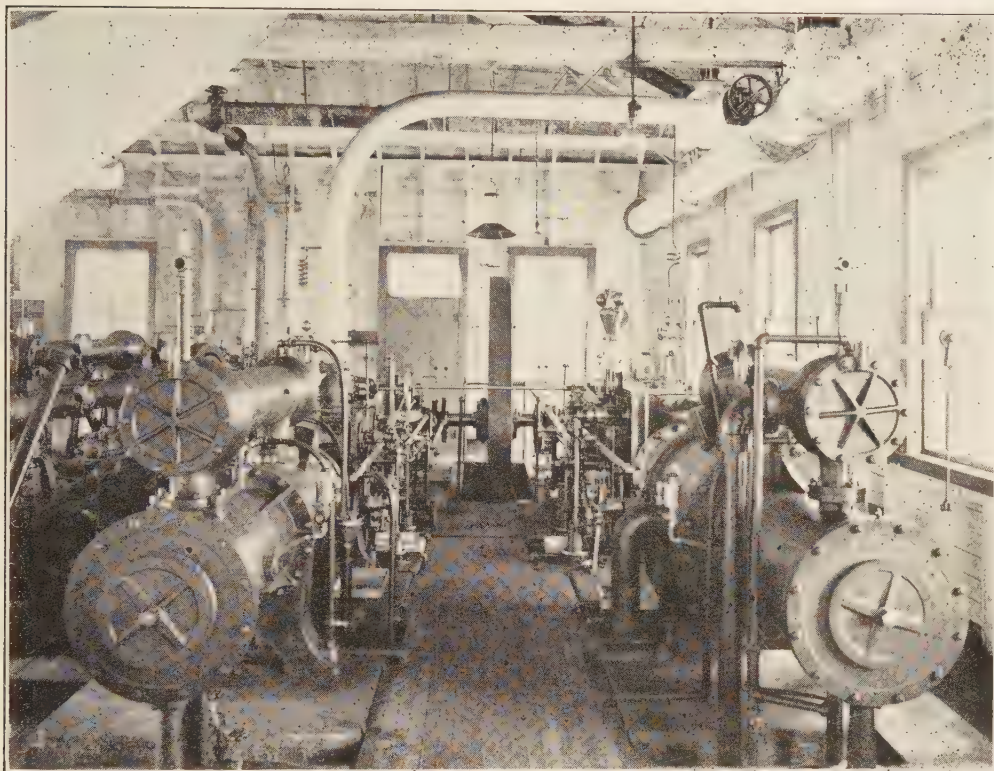


FIG. 6. FOUR-STAGE COMPRESSOR
Sullivan Machinery Co.

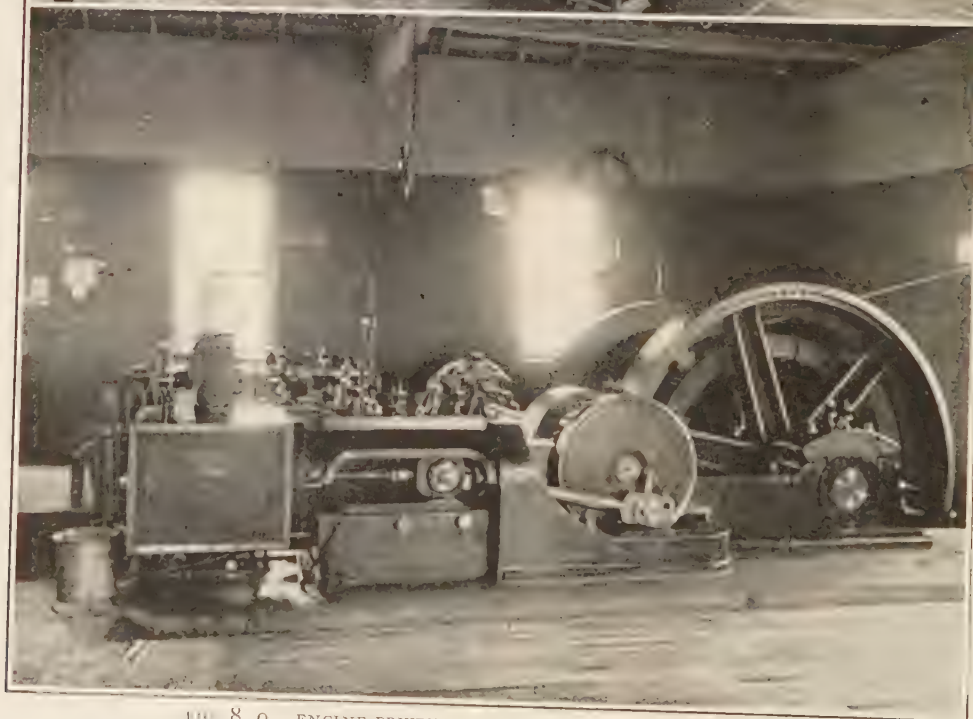
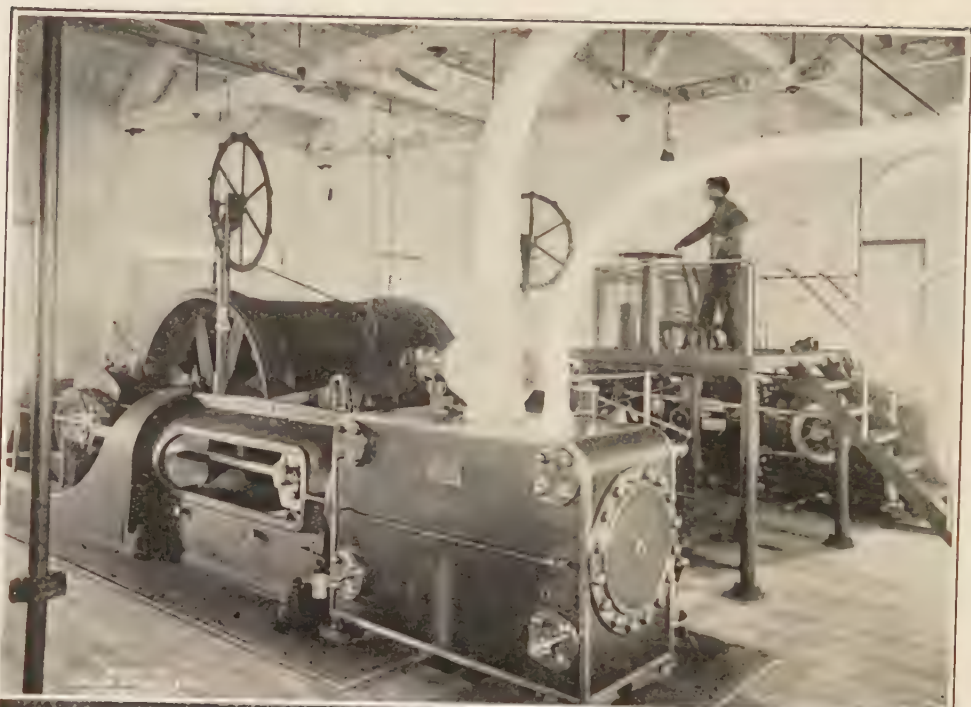
placed outside of the air cylinders. This compressor will soon be changed over to operate by electricity from the new water-power station of the Cleveland-Cliffs Company.

In the compressors shown in Figures 1 and 2 the air valves are of the Corliss type. In Figure 3 is shown a compressor with poppet or lift valves in the air cylinders. The air is taken in through the hollow piston rod into the piston, in the face of which are located the valves. The steam cylinders are of the Corliss type, cross-compounded, and are located between the air cylinders and the shaft, the air cylinders being on separate foundations and connected to the steam cylinders by distance pieces only.

In some compressors the air-inlet valves are of the Corliss type while the discharge valves are of the au-

tomatic poppet type. Such a compressor is shown in Figure 4. This machine is of the two-stage type, with cross-compound Corliss steam cylinders, and has a capacity of 3,600 cubic feet of free air per minute compressed to 100 pounds pressure.

Where electricity is available, motor-driven compressors are used exclusively. Motors used are compound-wound, direct-current, self-starting synchronous, or phase-wound induction alternating-current motors, the alternating-current types being used wherever possible. Figure 5 shows a compressor driven by an alternating-current motor. The starting motor is placed between the frames of the compressor and belted to the flywheel. This compressor has an automatic clearance controller, a device for economically regulating the capacity of the compressor by



8, 9. ENGINE-DRIVEN HOISTS AT AMERICAN IRON MINES

Above, Corliss-engine hoist; below, automatic cut-off slide-valve engine hoist, Buckeye Mine, Commonwealth, Wis. Both by the Sullivan Machinery Co.

varying the amount of clearance. It consists of a number of clearance pockets which are thrown automatically into communication with the ends of the air cylinders in proper succession, this process being controlled by a predetermined variation in the receiver pressure. With the compressor operating at partial ca-

pression throughout the entire load range.

When compressed air is used for mine locomotives, the air is charged into the storage tanks of the locomotives at a very high pressure, usually 1,000 pounds per square inch. The compressors used for this work are of the four-stage type. One of these,

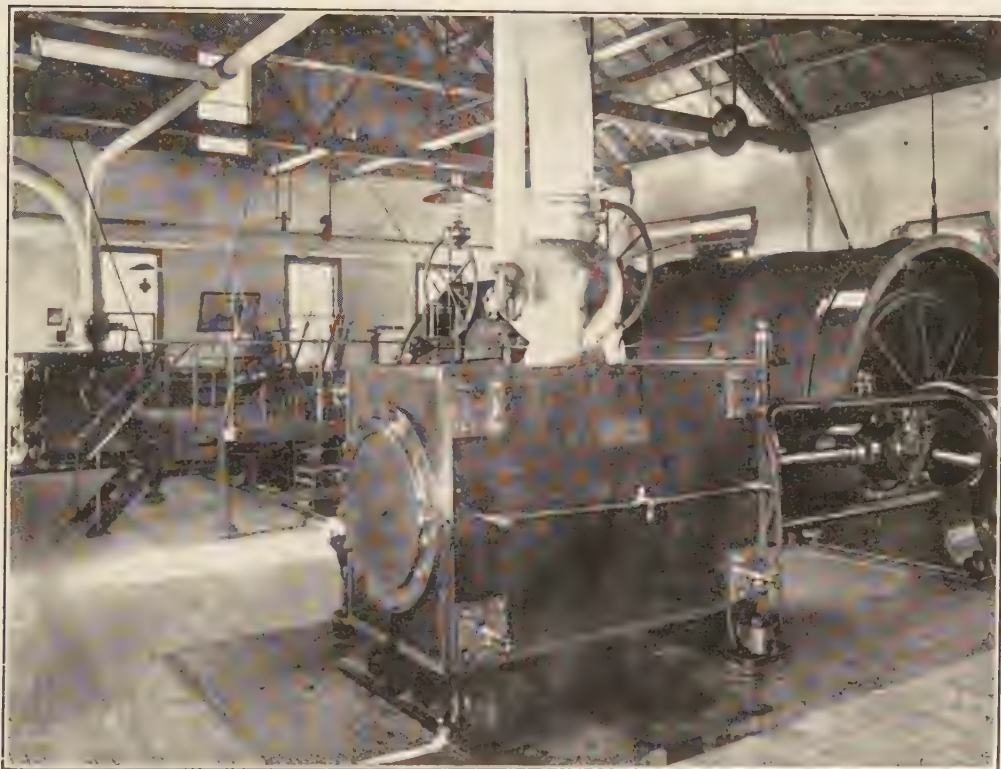


FIG. 10. DIRECT-ACTING HOIST, ARAGON MINE, OLIVER MINING CO
Sullivan Machinery Co.

capacity, a portion of the air is compressed into an added clearance space instead of passing through the discharge valves. On the return stroke this air expands, giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure. On a two-stage compressor, clearance space in proper proportion is added simultaneously to both high and low-pressure cylinders, thus maintaining a constant ratio of com-

shown in Figure 6, is located at the Aragon mine of the Oliver Mining Company, Norway, Michigan. This compressor has a delivery capacity of 450 cubic feet of free air per minute compressed to 1,000 pounds.

HOISTING ENGINES

There are three important qualifications required in hoisting engines for mine shafts or slopes. The hoisting must be done rapidly, the engine must be reliable, and the whole hoisting apparatus must be automatic so

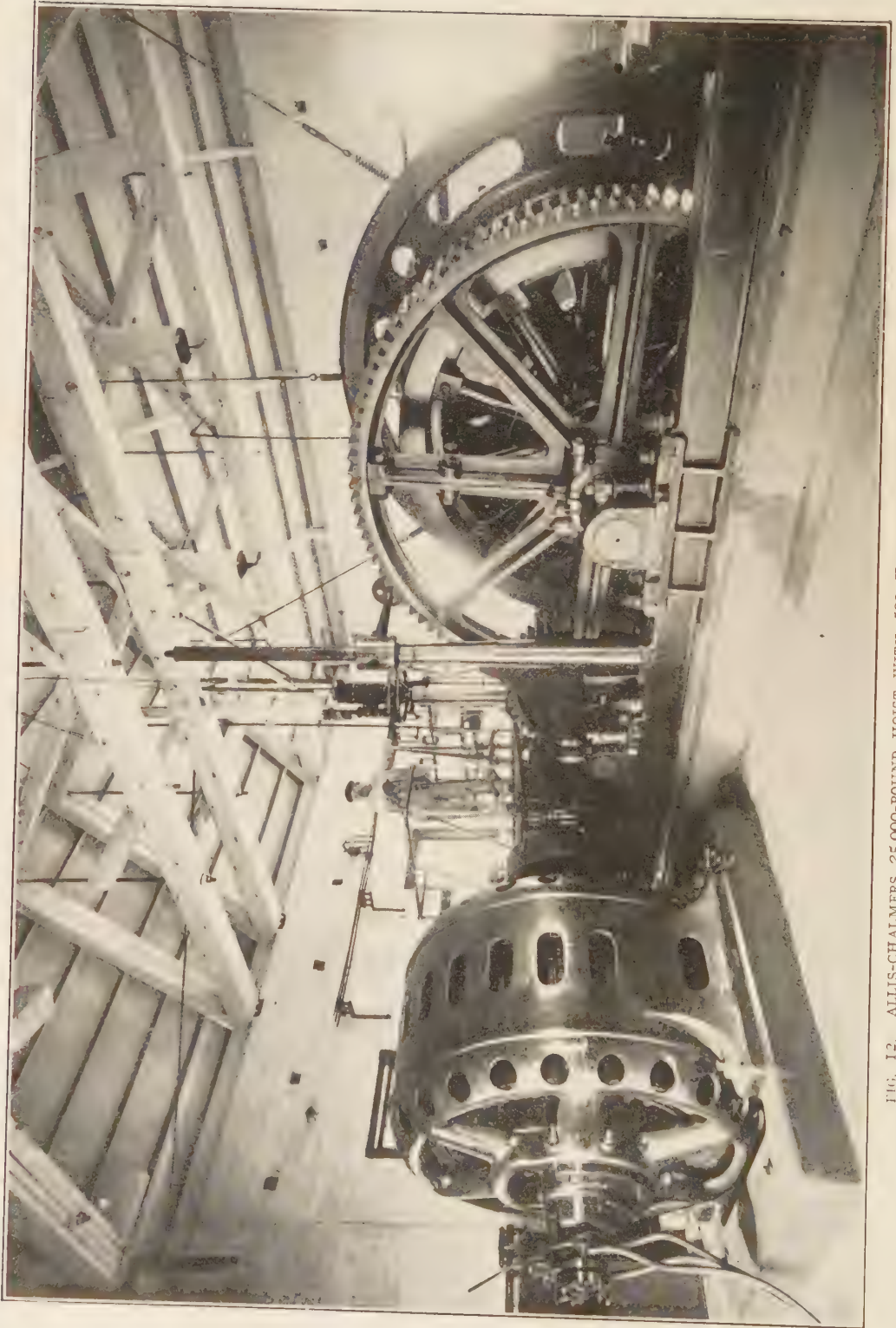


FIG. 12. ALLIS-CHALMERS 25,000-POUND HOIST WITH 500 HORSE-POWER 3,300 VOLT INDUCTION MOTOR

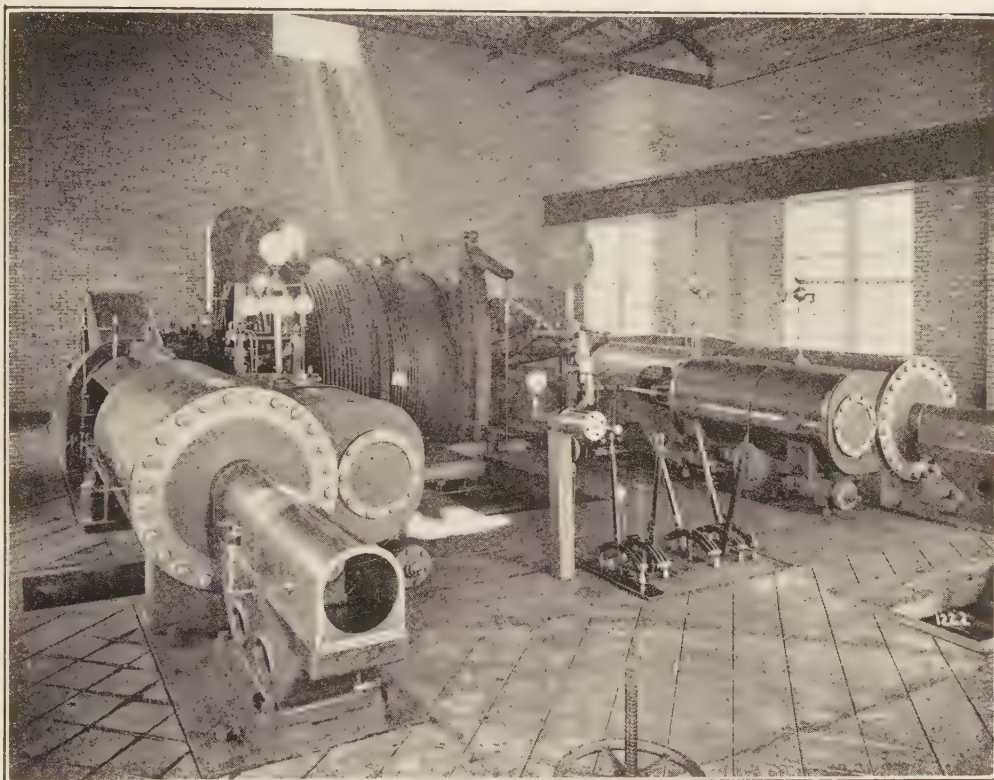


FIG. 11. HOISTING ENGINE, 22,000-POUNDS CAPACITY, FOUR HOISTS PER MINUTE, FROM THE 500-FOOT LEVEL
Mesta Machine Co.

as to not depend on the hoisting engineer for stopping.

Figure 8 shows a type of hoist used largely in the Lake Superior Region for deep mines. This particular installation is at the Prince of Wales mine of the Oliver Mining Company, Negaunee, Michigan. The engine, of the Corliss type, is reversed by link motion. The drum is 12 feet in diameter, is keyed to the shaft and carries two ropes, the hoist being balanced. The engine, the cylinders of which are 26 by 60 inches, is fitted with an automatic throttle closing device and automatic brake. The hoisting speed is from 2,000 to 2,500 feet per minute and the depth of hoist is 2,000 feet.

The Corliss engine was first introduced for hoisting purposes in the iron mines about fifty years ago. At

first the engines used were standard mill engines; some were geared to the drums and others were direct-connected. The drums were usually built at the mines out of wood. The Corliss engine is now used almost exclusively in mines more than 1,200 feet deep and is always direct-connected to the drum. It is out of the question to use Corliss engines for hoisting in mines only a few hundred feet deep, on account of limitations in speed of the Corliss gear, demanding engines large for the service required. In the comparatively shallow shaft, after the load is accelerated, but a few revolutions of the engine will be made with the automatic cutoff in action if the engine were direct-connected to the drum. Thus the Corliss engine would be not only excessively high in first cost but

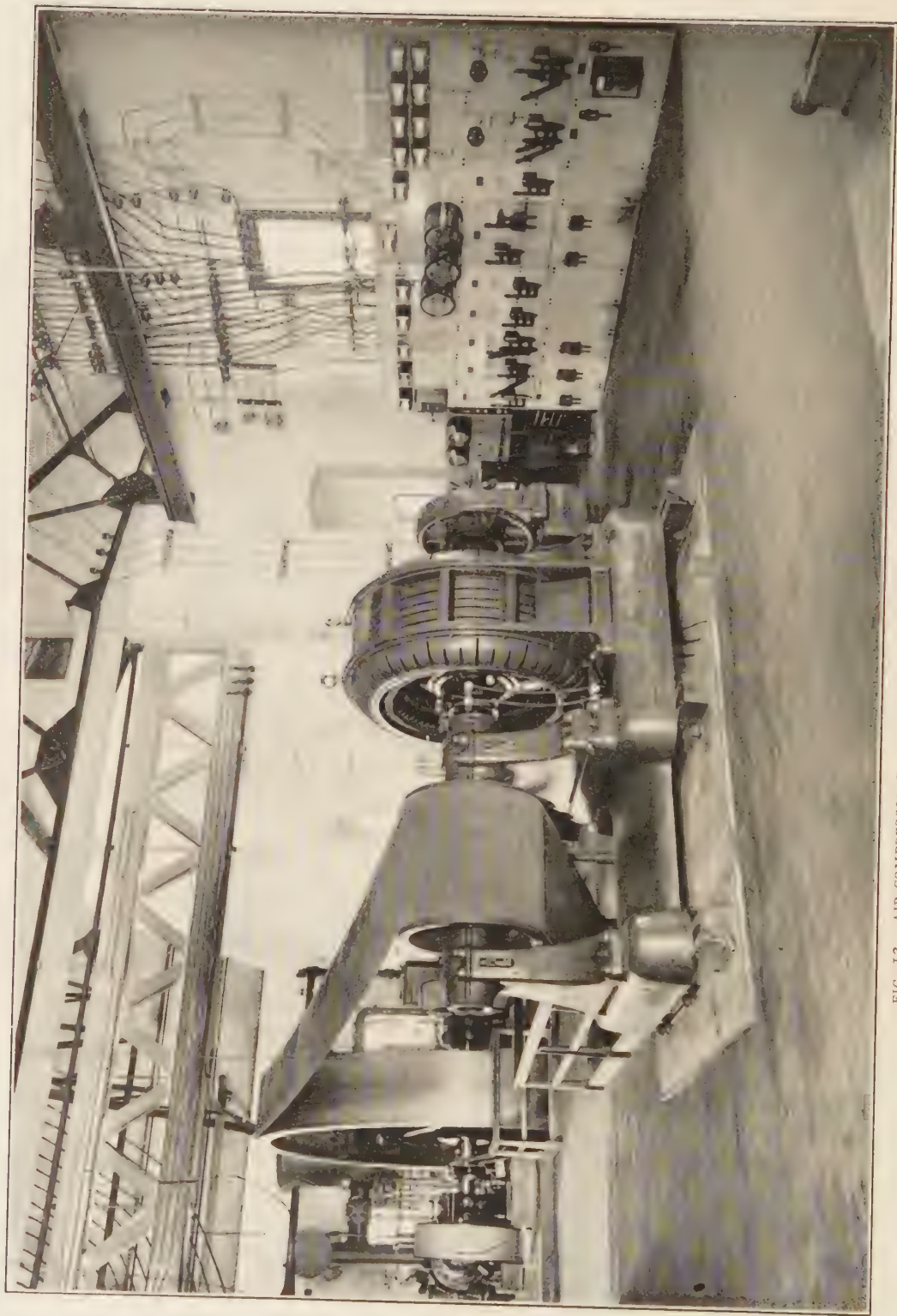


FIG. 13. AIR-COMPRESSOR FOR WITHERBEE, SHERMAN & CO., MINEVILLE, N. Y.
Capacity 2,500 cu. ft.; 400 horse-power, 3,300 volt synchronous General Electric Motor

would also be more extravagant in the use of steam than a slide-valve engine.

The kind of engine that is used for shallow mines is the high-speed, slide-valve type, geared to the drum. Steam pressures used are in the neighborhood of 150 pounds. As automatic cut-off mechanism is fitted to this type of engine by the Sullivan Machinery Company, so that when the load is being started at the bottom of the shaft, the cutoff, for a revolution or two, will be at about three-fourths stroke, but this is shortened up in a very few revolutions until the cut-off occurs at about one-third stroke. This cut-off then remains constant until the engineer shuts off the steam at the top of the shaft. The change of cut-off is effected through an aux-

iliary steam cylinder which operates a riding cut-off valve on the main slide valve. The amount of steam admitted to the auxiliary cylinder is controlled by the main throttle lever. When the engineer opens the throttle part way for starting, the cut-off is late, but as the throttle is opened wider more steam is admitted to the auxiliary cylinder, making the point of cut-off earlier in the stroke.

Figure 10 shows a direct-acting hoist at the Aragon mine of the Oliver Mining Company, Norway, Wisconsin. The two cylindrical drums are 12 feet in diameter by 10 feet 6 inches long and are clutch-driven. The Corliss cylinders are 28 by 60 inches. The hoisting speed is 2,000 feet per minute. This hoist is equipped with automatic throttle-



FIG. 15. FIVE-TON 220-VOLT DIRECT-CURRENT LOCOMOTIVE, BARTON HILL TUNNEL. WITHERBEE, SHERMAN & CO., MINEVILLE, N. Y.



FIG. 14. FOR RAILWAY WELLMAN-SHERMAN HOIST DRIVEN BY 300 HORSE-POWER 440-VOLT GENERAL ELECTRIC MOTOR.
WITHEPP, SHERMAN & CO., ALBANY, N. Y.

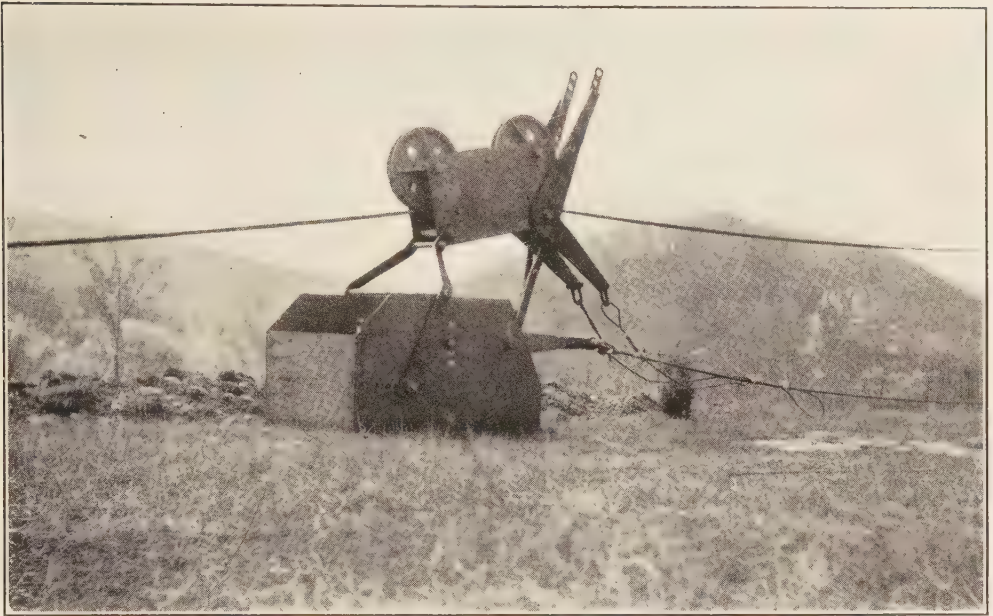


FIG. 16. CABLE EXCAVATOR BUCKET OF $2\frac{1}{2}$ CUBIC YARDS CAPACITY, CARPENTERSVILLE, N. J.
Built by Cable Excavator Co.

closing device and automatic interlocking brake. The function of the first mentioned mechanism is to close the throttle automatically at some predetermined point in the hoist, allowing the cage or skip to come to the landing by the momentum of the moving parts. It is impossible for this hoist to reach the landing under steam in any circumstances; and when once the throttle has been closed it cannot be opened again until the engine is reversed. If the engineer should neglect to apply the brake in season to prevent the cage or skip from passing the dump, an automatic trip and lever opens the brake throttles and applies steam at full pressure, so that the hoist is brought to a stand still and overwinding is prevented. When this occurs, the brakes are locked in position and cannot be released, nor can the throttle be opened, until the engineer leaves his platform and removes the releasing pin. Such a device as this is absolutely necessary as it provides complete safety to men, materials

and machinery and eliminates all danger of overwinding at the high speeds which are now necessary in the iron country to get out the tonnage called for by modern requirements.

Electric hoists are used to some extent where power is available. Where this power is transmitted some distance, the motors used are of the alternating-current type. The drums are thrown in and out of gear by either hand or power clutches. These hoists have one, two or four drums. One of the largest electric hoists in the United States, 25,000-pounds capacity, is located at No. 3 mine of the Woodward Iron Company, Birmingham, Alabama. This hoist has a rope speed of 700 feet per minute, one drum controlled by a power-operated band clutch and brake. The motor, which is of 500 horse power, is of the induction type and takes three-phase 25-cycle current at 3,300 volts.

The mines of the Witherbee, Sherman Company, at and near Mineville,



FIG. 17, 18. CABLE EXCAVATORS TAKING MATERIAL FROM BELOW THE SURFACE OF THE WATER AND DUMPING INTO CARS FROM THE TOWER

New York, have recently been equipped with electrical machinery throughout. The mines are so located that individual hoists, compressors, and concentrating plants are necessary. The company has built a two-unit turbo-generator plant containing units of 800 and 1,500 kilowatts capacity respectively, at Port Henry, N. Y., six miles from the mines, and

160-pounds pressure with 100 degrees superheat. The generators deliver three-phase 6,600-volt current to the transmission line, which extends to a transforming station in Mineville where the voltage is stepped down to 3,300. From this station the current is distributed to the hoist and power houses, where some of it is used at 3,300 volts and



LIDGERWOOD-CRAWFORD EXCAVATOR WITH PAGE BUCKET, DIGGING ORE ON THE PROPERTY OF THE SPANISH-AMERICAN IRON CO., NEAR NIPE BAY

Three of these drag-line excavators are used for stripping the over-burden and excavating the ore. They sit on top of their work at all times—not in the ditch

has installed a 750-kilowatt low-pressure turbine at the 1,000 horse-power Corliss-engine plant at Mineville. Two hydroelectric plants can be relied on to furnish 675 kilowatts during a greater part of the year.

The steam-generating plant is up to date in every particular. The turbines are of the Curtis type, built by the General Electric Company, and the boilers are Babcock and Wilcox, burning No. 2 buckwheat anthracite coal which costs \$2.65 unloaded at the plant. Steam is generated at

some stepped down for use at 440 volts. Any one of the four plants, the turbine, hydraulic or Corliss engine-turbine plant, may be run separately, or all four may be run in parallel to supply the system.

Among the motor-driven machines are two 2,500 cubic-foot air compressors driven by 400 horse-power 3,300-volt synchronous motors, and two 1,200 cubic-foot compressors driven by 200 horse-power 440-volt induction motors. There are three electric hoists, one 300 horse-power

motor geared to a four-drum hoist, one 500 horse-power motor geared to a two-drum hoist, and one 100 horse-power motor geared to a two-drum hoist.

During 1910 the total cost of generating power in these stations was 1.3 cents per kilowatt hour. The cost of power per ton of ore was 19.1 cents, including fixed charges. The distribution of load for the year was as follows, in kilowatt hours: compressors, 4,797,918; mills, 1,967,776; hoists, 755,599; pumps, 207,031; miscellaneous, 475,867; commercial power, 575,579; total, 8,779,800 kilowatt hours.

The foregoing illustrations and descriptions apply only to the extraction of ore from the earth by the mining method and not by stripping. Where stripping is practiced, as on the Mesabi Range in Minnesota, no hoisting apparatus is required, but the ore is loaded direct into cars with steam shovels. This method was illustrated in the author's paper in *THE ENGINEERING MAGAZINE* for June, 1911.

Another system of stripping and loading ore, coal, gravel or other material has lately been perfected. This is the slack-cable system built

by the Cable Excavator Company of Philadelphia. In this system a carrying cable is stretched from a tower located on one side of the material to be excavated to an anchor on the other side. This cable carries a bucket of $\frac{1}{2}$ to $2\frac{1}{2}$ cubic-yards capacity. The bucket is moved along the carrying cable by a smaller draft cable. The tension in the carrying cable is entirely under the control of the operator, this tension being varied by a drum on the hoisting engine or by a set of blocks. As the carrying cable is slacked, the bucket runs by gravity to the point to be excavated; then the cable is further slacked until the bucket rests on the ground. By means of the draft cable the bucket is then drawn along the ground until filled, after which the carrying cable is pulled tight enough to allow the bucket to be drawn to the tower, or dumping point, where it is automatically dumped.

With a bucket of 1 cubic-yard capacity, fitted with manganese teeth, hard clay can be dug at the rate of 1 yard per minute. The cost of excavation with this system, including crushing, screening and loading into cars, is from 5 to 7 cents per ton of material excavated.



CONSTRUCTION AND OPERATION OF TURBO-BLOWERS AND COMPRESSORS

II. TEMPERATURE EFFECTS AND COOLING DEVICES

By Franz zur Nedden

Mr. zur Nedden's purpose, as outlined in introducing the first paper of this series, is a discussion of the mechanical evolution and operating economy of turbine machines. The present paper points out the influence upon mechanical design effected by the reduction in the volume and the increase in the temperature of gases on compression.—THE EDITORS.

IN the preceding article in this series a comprehensive review was made of the fundamental principles of design of turbo-machines handling air and gases. Particular stress was laid first upon the advantages possessed by turbo-blowers and compressors in comparison with piston types, and second upon the considerations entering into the problem of handling gases which are new and different from those controlling the design and construction of turbo-machines for handling liquids. The characteristics of the radial and axial types were compared, leading up to the conclusion that because of the physical properties of gases (reduction of volume and increase of temperature on compression) turbo-blower designers must confine themselves to smaller heads per stage

than would be used in the design of machinery for pumping liquids. This limitation of the head per stage has the advantage of simplifying the problem of reducing leakage losses between stages, the means employed for this end constituting another deviation from turbo-pump design.

INCREASE OF TEMPERATURE

Increase of temperature makes special cooling arrangements indispensable, especially with turbo-compressors, i. e., with machines compressing air to more than 20 pounds per square inch absolute pressure. Economical cooling becomes a vital question in the thermic efficiency of the compressor. On this point, it decidedly excels the piston compressor, as it is impossible to cool the air continuously when it is compressed in cylinders. This, however, becomes

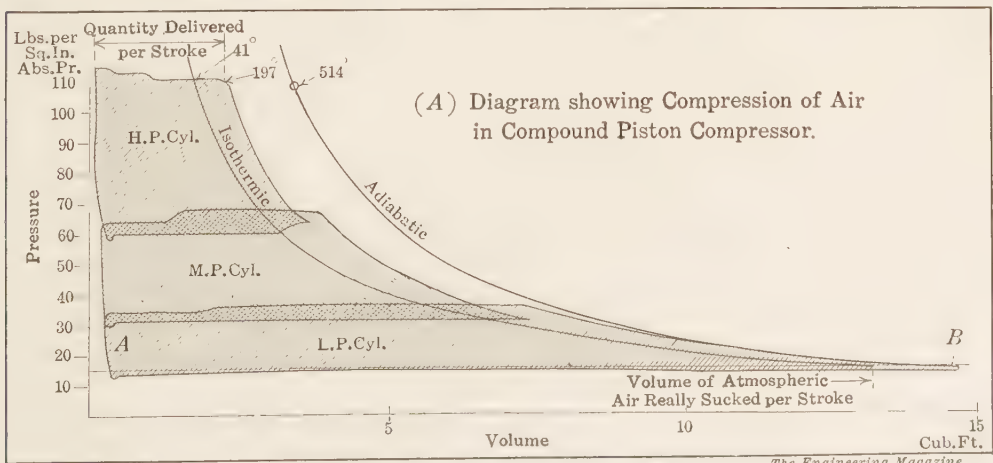


FIG. 8. COMPRESSION DIAGRAM, THREE-STAGE COMPOUND PISTON COMPRESSOR

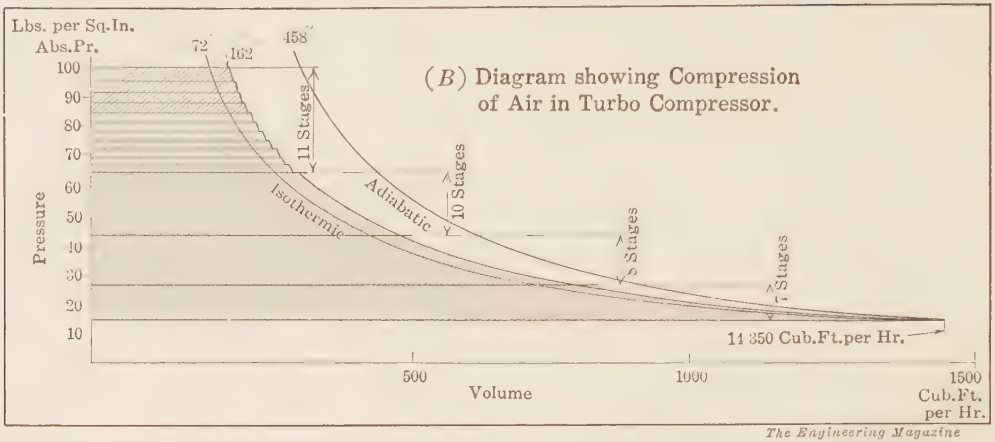


FIG. 9. COMPRESSION DIAGRAM, TURBO-COMPRESSOR

quite feasible in the turbo-compressor (see Figures 8 and 9). Here jacket cooling is the most important part of the whole cooling system, and the special intermediate coolers used between the separate cylinders of compound piston compressors are generally considered wholly unnecessary in the turbo-compressor. In the turbo-machine compression of the air proceeds much more gradually, the distance traveled by every particle of air is consequently much greater than with piston compressors, and the entire area available for the cooling influence of the water is many times as large as that in the piston compressor of equal capacity; therefore, the air pumped by the turbo-compressor

remains at nearly constant temperature throughout the operation. Cooling arrangements disposed on the counter-current principle can easily be given maximum effectiveness, a condition not readily attained in compressors of piston type.

Advocates of the piston compressor are fond of pointing out that the cooling effect of the water must be much greater in an intermediate cooler of a compound compressor than in the jacket cooling of the turbo-compressor, because the temperature difference between the air and the cooling water is much greater, and therefore a smaller quantity of cooling water will produce greater effect in these intermediate coolers. This ar-

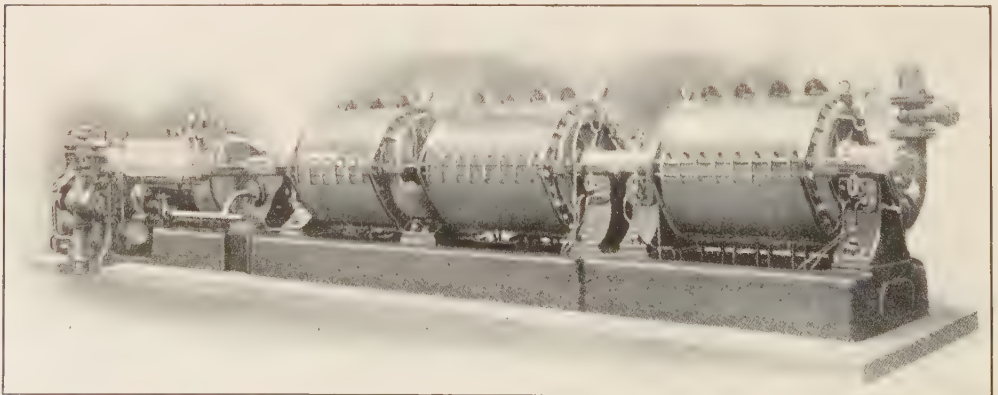


FIG. 10. WATER-COOLED TURBO-COMPRESSOR, SOCIÉTÉ DES TURBO-MOTEURS À COMBUSTION, PARIS
Delivers 212 cu. ft. per second against a pressure of 50 lb. per sq. in.

gument is easily met, as the principal art of compressing air with high thermal efficiency is to accomplish the result with as small a temperature rise as possible. If a very high temperature is developed, it is not sufficient that this result is corrected by a minimum of cooling water; it is far better to use a maximum of cooling water in preventing the temperature rise than it is to reduce this afterwards. Speaking more scientifically, the mere fact that a turbo-compress-

contains seven or eight stages. Each casing is separable horizontally into two parts, a form which seems to have become standard for turbo-compressors as it has for steam turbines. The cooling water enters the casing from below at the highest pressure stage of the group. It passes thence to the upper part through copper tubes, clearly seen in Figure 10, goes through a core hole at the top of the highest stage into the upper half of the highest stage but one, and again

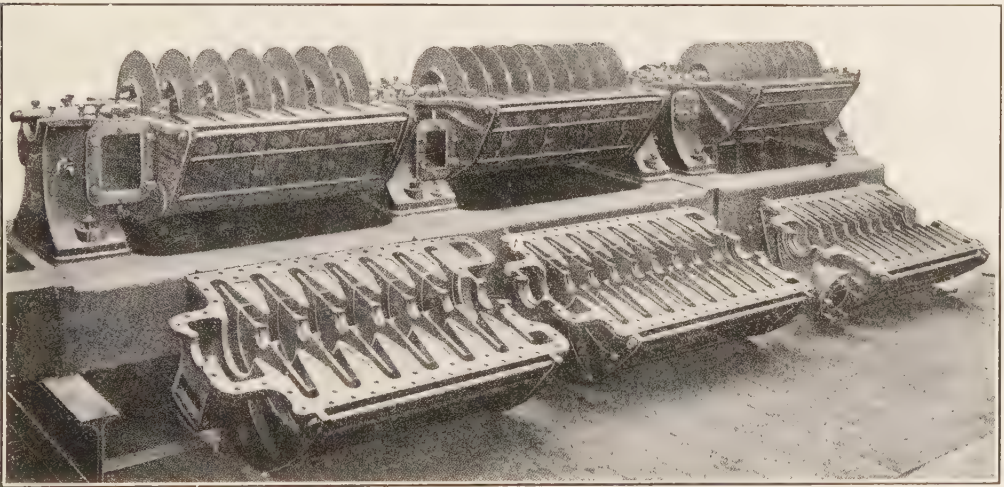


FIG. 11. COMPRESSOR BUILT BY BROWN, BOVERI & CO. FOR THE SOCIETE DES TURBO-MOTEURS

or must have a greater number of stages (up to thirty or more) permits the actual process to be brought much closer to the isothermic ideal than would even be contemplated with a three-stage compound piston compressor. (See Figure 8.)

COOLING DEVICES

The principal differences noticeable between various turbo-compressor systems are in their cooling arrangements. Not even the licensees of Prof. Rateau use a uniform cooling device. Figure 10 shows one of the first water-cooled Rateau compressors which has been successful in practical operation. Figure 11 shows its internal features. Each of the three groups coupled in series

through copper tubes into the lower half, whence it goes through a core hole into the lower half of the next lower stage, and so on. Later, the copper pipes were replaced by small bored holes passing through the horizontal joints (see Figure 11). This system has the disadvantage that there is no assurance that the water shall completely fill up the cooling chamber, as the core holes are not always at the very highest points of the chambers.

Messrs. Brown, Boveri & Co. avoided this difficulty, and, moreover, greatly enlarged the cooling area by casting the vanes hollow, thus leading the air back to the center, and creating a separate

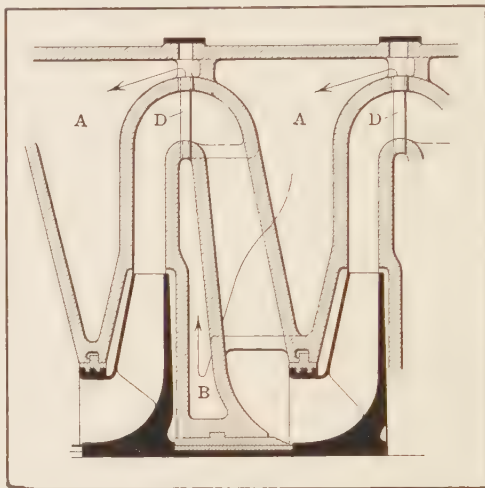
interior cooling chamber *B*, Figure 12. The water, after filling chamber *A*, flows through the hollow guide vane into chamber *B*, and thence by special pipe *D* (which is screwed into chamber *B* at its highest point) to the highest point of chamber *A* of the next stage. Though the excellence of this system cannot be denied, it is, on the other hand, very expensive, for the castings become highly complicated, and the foundry work, moreover, must be such as to guarantee that all surfaces are absolutely smooth, as it is proved that the frictional resistance of air is greatly dependent on the roughness of the surface over which it passes. The cost of casting these casings was about $5\frac{1}{4}$ cents a pound in place of $3\frac{1}{2}$ for average casings, and even then this famous foundry could not avoid 15 to 20 per cent waste.

C. H. Jaeger, of Leipzig, therefore, wisely separates the casing of his turbo-compressors into as many chambers as there are stages, and screws these together as shown in Figure 13. Furthermore, he separates each stage into an upper and lower half. Though this system increases considerably the number of machined surfaces, it nevertheless insures small casings and enables the maker to manufacture the single stages on a large scale and to combine out of

stock as many as are needed for any special requirement.

EXPANSION OF CASING

Another effect of temperature rise, and one which acts on the machine, is the expansion of the casing by the

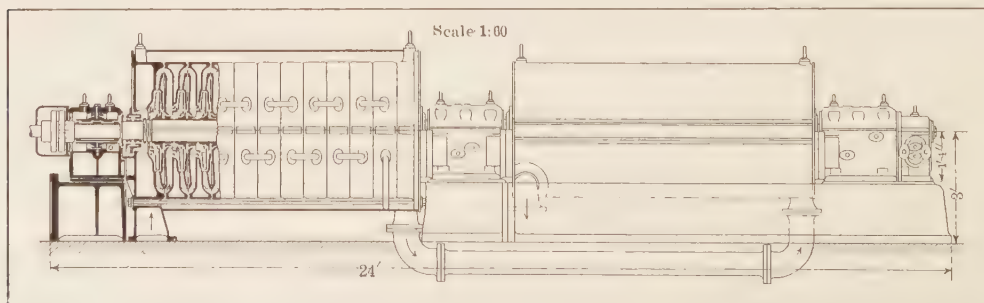


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FIG. 12. IMPROVED COOLING SYSTEM FOR TURBO-COMPRESSORS

Brown, Boveri & Co.

heat. Special preventive measures must therefore be taken to avoid any alteration in the relative position of the casing and the runners. As the casing rests by lateral supports on the bed-plate, the absolute height of its center above that bed-plate will change as soon as the casing becomes heated and expands. If the shaft, revolving within this casing with a clearance as small as $1/1,000$ of an inch, is supported by bearings which



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FIG. 13. WATER-COOLED JAEGER TURBO-COMPRESSOR

Delivers 3,500 cu. ft. per minute against 100 lb. per sq. in. when running at 3,000 r.p.m.

remain practically cool, the distance between the center of the shaft and the bed-plate will remain unchanged. Therefore, the centers of the casing and of the shaft, which may coincide when both are cold, must differ as soon as the blower comes into operation and the temperature of the casing rises. The clearances will then not only become eccentric, but very probably the shaft and the vanes of the impellers will come into close contact with the fixed parts, causing heavy friction, and owing to the absence of any lubricating medium they would very likely seize.

Designers of turbo-compressors have overcome the difficulty of axial expansion by means already well known in the steam engine and the piston compressor. These difficulties are of course larger with long-extended turbo-compressors than with single-casing turbo-blowers. The

blower illustrated in Figure 7* rests with one end only on the bed-plate, the other end being free to move or expand. When additional stages are required, the design must be altered to a form now quite generally adopted by the licensees both of Prof. Rateau and Messrs. C. H. Jaeger & Co. The body is supported only by the two terminal covers which carry the bearings. One of the bearings is fixed rigidly to the bed-plate, whilst the other is allowed to slide to some extent on the machine rest. (See Figure 13.) With very long blowers, it might perhaps be advisable sometimes even to support the body by lateral feet, the machined surfaces of which might move freely on the bed-plate on exactly the same horizontal plane as the axis of the blower. In this way radial expansion would not alter the height of the geometric center of the casing above the bed-plate.

*See THE ENGINEERING MAGAZINE for July, 1912, page 551.

COST METHODS THAT GIVE THE EXECUTIVE CONTROL OF HIS BUSINESS

VIII. COST SYSTEM—THE BASIC IMPROVEMENT

By Benj. A. Franklin

Mr. Franklin concludes this month a series which began in our issue of January, 1912, and which has been designed throughout to show how cost accounts may invaluablely help the manager—not how cost forms are to be filled out by the cost clerk. His topics have been: "The Philosophy of Costs"; "The Place of the Trial Balance in the Cost System"; "The Cost of the Salable Article"; "The Economic Consideration of Material by Costs"; "Labor from the Cost Viewpoint"; "The Vexing Question of Expense"; and "Statistics as an Aid". The whole group will shortly be published in book form.—THE EDITORS.

THAT the future of the cost system is to be one of universal and valuable employment, and of higher and more practical development, is assured by many growing necessities, not only intimate to the individual plant and its proper management, but requisite as well to the common welfare in the advancement of industrial development and its economic aid and con-

trol by law, which latter it seems business is not to escape.

If, for example, our tariff is to be adjusted scientifically on a basis of actual costs, as attempted by the late Tariff Commission, it is, in fairness to all, essential that there be in existence not merely general figures giving unit cost on bulk production, but complete costs in various like plants, uniform in method and dis-

criminating as to grades and qualities. Not for long can certain general expenditures, averaged over total production, serve a final and just purpose.

Then there is a continuous outcry against the high cost of living, and there grows a public suspicion that this exists not merely because of a depreciation of gold and advancing wages, but because of undue profits on the part of capital, and such ideas as the Government control of prices are seriously advanced. Yet prices could never be justly controlled, nor indeed an investigation render a properly reasonable basis for action, until a fair number of like plants have discriminating and uniform cost systems. And certainly no such condition exists at the present time in any large proportion of the different classes of manufacture, though concerted action by associations of manufacturers is tending to bring this about.

If, then, the Government is to regulate matters that have to do with prices and profits, it would seem that it must likewise assume the responsibility of forming a proper basis of knowledge for such action. This, of course, opens up a wide problem with which the Government is not entirely unfamiliar since its work with railroad accounting, but which it has not been able to solve successfully as yet in its own departmental affairs, according to the President's message to Congress on Economy and Efficiency in Government Service.

It has been suggested in another connection that a Government bureau might render valuable aid to our manufacturing industries by studying their problems in some detail, as it has those of the agricultural industry, in which case there might be a reversal of the opinion held today by many manufacturers

—that the Government is too busy telling them what they can not do to give any valuable information as to what they may, with profit, do.

To one who has studied costs and their value, and seen the practice active and effective in control when properly operated (though widely variant in principles and methods of application) and who has reflected on the tremendous and growing ramifications and difficulties of this great industrial era, the value (and indeed the necessity) of control, and the necessity of basing remedial action on the real facts of the situation, it would seem that a Government Bureau of Industrial Research might render substantial values. Its problems would be large, and diplomatic as well as practical, since manufacturers have ways of their own to which they are much attached, and are slow to absorb the methods of others no matter how alluring in the recital. But its first work must essentially be the study, devising, and publication of practical and discriminating cost systems for various classes of manufacture, since all other experiments must meet the test of comparative costs. And the publicity of any investigation it might be authorized to make, when such were based on a pre-established method, would go far toward showing remedies for situations now very puzzling. In any case, it is entirely logical that much economic business law of future construction must have a basis of proper costs. The wise executive will prepare himself for this, and it is not an entirely disquieting thought for him, that if such laws may seem to hamper him, they will likewise hamper his competitors and render him equal justice with them.

But apart from any such ideas, the value to the individual plant of the

right and practical cost system is an ample compensation for its careful and detailed employment.

It might appear valuable here to give some idea of what is a right and practical cost system (for its development is somewhat modern, and its importance even more so) on account of its value in the introduction of modern methods of management.

Accounting, since the introduction of the double-entry book-keeping system, has reached a high state of development in rendering exact account of receipts and expenditures of a business. In its most universal practice, it has to do with the payments of bills for whatever purpose, with the accumulation into certain general or desired classifications of amounts of expenditure covering the total over given periods, and with the billing and record of all items of sale, and their classifications. It has to do with the changing records of assets and liabilities, and, through periodical actual inventories, with the showing of gross and net profits. It has to do with a proper showing of the debts of the business and the amounts owing to it. It has to do with credits, finances, bank relations, notes, drafts, etc. In fact, it has developed into a complete showing of the business in its relation to other businesses in detail, and only a general showing of the internal operations under certain heads with a periodical net result.

In the profession of accountancy there has been developed an expert body of accountants and bookkeepers, to whom is entrusted much in confidence, and whose work develops or demands a certain temperament.

The cost system takes hold where accounting leaves off. It has in common with accounting only two things—the use of the same set of figures of expenditure, and the value of the

accounting as a means of proof. It deals with internal affairs only, in contradistinction to accounting's dealing with external affairs. Accounting and costs are complements in a showing of the operation of a business.

In its dealings with the internal affairs of the business, the cost system, to be right and practical, must not merely present fairly true and proved costs of all articles produced (which has long been considered the chief if not indeed the only use of a cost system), but it must present constantly and comparatively pictures of the progress of certain sections of the business, showings of the divisions and departments, wastes, variations from the standard of costs of operations of labor and expense. It must, beginning at general or specific totals, be prepared to run back over the ground and show fact and reason, in slightest detail, of differences observed by comparison, or of operations desired for whatsoever reason. It must follow production and illustrate its variations and the results to the welfare of the business. To it material is but base cost and waste; labor is but an instrument of production whose reward is constantly to be gauged by its effect on the unit cost of production; expense is an element whose value is to be determined by its effect on, and increasing or decreasing relation to, the article cost. The cost system, in fact, should become the moving-picture film of the business in its constant internal mutations. When it has become so, then it will be found offering, urging, and indeed forcing, methods of improvement and control.

In the modern struggle for improvement, scientific study of management methods, and lower cost, (or rather, as the race now runs, of

the prevention of too great cost-increase), the practical cost system must be the foundation stone. In the mind of every sensibly ambitious and up-to-date executive, looking for methods which will render to his employees and his stockholders as well as to the public the best service, the cost system must strike the keynote, for it will prove not only a constant prodder as to the necessity of change and improvement, but it will point the weak spots, and it will differentiate the values of different methods.

The executive desiring to keep up to date, to install in his plant better methods of organization, of wage payment, of work routing, of production increase, of waste saving, of sales increase; in fact, of general or specific improvement, or to maintain what he has, will do best to make sure first that he has a right and practical cost system, for cost system is the basic improvement. Figures form the body of costs, but the right and practical cost system has a soul that keeps demanding right shop methods.

This division between the accounting and the cost system, the one showing the external and the other the internal affairs of the manufacturing plant, has never been well understood or acknowledged, although practiced in many plants, because the cost system has not been developed as ably and exactly as has accounting; because both use figures as an instrument, it has not been appreciated that a practical cost system is more a presentation of ideas than accounting. And this failure has brought about a definite weakness in the cost system. The good accounting system has an extreme similarity in all businesses, but while the principles are the same, the proper practice of the cost system varies

materially in different plants, according to conditions, nature of organization, circumstances, and kind of manufacture.

In general, then, the cost system; for best value, demands, both in introduction and in practice, a somewhat different experience and different temperament than does accounting.

It needs likewise what it has not obtained in very many plants—an understanding by the executive of its principles, its practice and its possibilities. The practical man is too liable to look upon figures of cost with contempt when they do not show the results his judgment anticipated. Yet one of the first valuable effects of a cost system is to show the fallibility of the judgment of the practical man when he deals with costs. It would be a happier future for many plants if the superintendents were promoted to the cost department, or if their young men in training for future executive duties should take a course in this department.

But one thing ought to be clearly understood, *viz.*, that despite the constant talk of systems of all kinds, and their value, no business is made a success by them alone. Business success is made by policies, energy, enthusiasm, work, and sagacity. In a struggle of brains *versus* system, brains will usually win. System, and especially cost system, is merely a tool with which brains enhance its effectiveness by using it as a basis of knowledge to start with and as a check and framework to hold the whole together like the wax in a honey-comb, and it assumes importance only as intelligence, persistence, and energy wield it.

It has frequently happened that the tool has been built too large to wield, but it has also too often hap-

pened that even when properly built it has been put into the hands of an operative too weak to handle it. When, and where, the complete value of a cost system is understood, it will be found remunerative by the executive to put it in charge of a man who is well paid not only because he is expert with figures, but because he is practical, patient, a thorough investigator, analytical of mind, logical in his conclusions, and resourceful, just as the accountant is well paid when he possesses, in addition to his expertness, a watchfulness of external financial relations, and a trustworthiness. And such a cost man should have time not only to make the figures but to investigate and interpret them.

Now as to the weakness that has been developed in cost-system practice through the failure of the executive to busy himself with its understanding, and the failure to distinguish between accounting and cost system and the necessities of their varying practice, this has taken place at two points—its introduction and its practice.

In the introduction of cost system, accountants have taken the lead because of their expertness with figures, and not unnaturally; but they have too often failed either to have, or to get, the practical man's viewpoint in their structure, or, with an understanding of human nature, to create internally that enthusiasm and appreciation which alone can bring best results. Accountants have too frequently mistaken the form for the substance, for the strong tendency of accounting is towards form, and the strong necessity of a cost system is substance. The result has been in many plants a cumbersome and inefficient, even if not entirely ineffective, system. This is not to belittle accountants, who have an ample and

sufficient usefulness, and many of whom have also the requisite abilities for any work they may undertake. But this practice has led many impractical men into the industrial-engineering field.

Again, in the practice, the weakness developed has come about through the intrusting of the cost system into the hands of men with purely clerical ability, because of the failure of the executive to appreciate the values to be obtained from the employment of the more highly trained practical man.

Time must of course correct these weaknesses, but it can do so only through the education of the executive as to the values hidden in the right and practical cost system and this must come through the training of the younger generation.

It may not be considered amiss to repeat here that the best way to build a cost system is from the totals down to the details, and not from the details up to the totals. The former is the logical way for many reasons. It is easier to obtain the totals and to prove them correct, thus obtaining a sure foundation to build upon. It is a difficult and discouraging task to gather a great mass of details and prove them with totals, and where this has been undertaken it has usually resulted in the rendering of presumed, but unproven, costs of articles without those values of cost control which are essential to a good system. But if the system starts with the totals of the three general elements—material, labor, and expense—as proven with the accounting; divides these into sub-totals, and these into still other subdivisions, as circumstances and conditions of organization, of departments and divisions thereof, and of articles of manufacture demand, then the proceeding follows from proof to proof, and

from significant total to detailed analysis as is desired.

Such a scheme is of course naturally dependent upon the aim in view for the cast of its final analysis, for it should plainly be understood that with the mass of petty operations and changing situations which make up the total of production, a definite schedule of desired enlightenment must be made if the cost system is not to produce a mass of useless figures, or fall short of a full illustration of the whole situation. This is to say that the cost system should be planned in advance as to what it is to accomplish.

Two elements are very essential in the building of a cost system—persistence and time. It takes, in a plant of any size, from one to two years' time to build a good system, because so much human nature is involved, from the executive down, and persistence follows as an essential to these conditions. The firm support of the executive against all difficulties, physical and human, must be given.

A cost system is an encourager of high wages. There is, in many plants, an opposition to high wages due to the belief that increasing wages necessarily mean increasing cost. Of course, under certain conditions, as in a horizontal wage increase, this is so, but a study of the detailed wage situation through the cost system will almost invariably show, under right manufacturing conditions, that the earners of the highest wages are the producers of the lowest unit-cost.

The proper cost system is a selector and former of good organization, for it shows plainly the well operated and improving departments and those badly run, and forces necessary changes, or creates through its normal effect a more determined, re-

sourceful, and careful management; for cost is the basic improvement. But it does not stop at the executive organization. Its proper use gauges the value and efficiency of every operative, every machine, every method, and every operation. With the proper standards it thus becomes a valuable instrument, but it must be realized by the executive that in its ordinary use it is not a barometer but only a thermometer. It merely states the past occurrence and renders only the values which enthusiasm, resource, and intelligence draw from it. But with the proper use it can become not merely historical but prophetic, because once the cost system has established a clear backward trail of events, and reasonable methods of control of shop operations have been introduced, it is no difficult feat to prognosticate future results with it, either as to the article costs or as to sectional or total net results. And when this can be done the cost system is established.

A well operated cost system is a species of insurance. It insures against continuance of unprofitable policies, the taking of unprofitable orders. It is also a good credit maker. There is in mind the case of a manufacturer who during the recent panic, upon being refused a loan, took his cost system to the bank, and had no difficulty in persuading the banker that his business was conducted properly on a basis of knowledge.

In conclusion then, the logic, the common sense, and the business sense of the manufacturing situation is inevitable. Every manufacturing plant demands a cost system presenting regularly the facts of the situation. But just as a painting of the veriest amateur may be labeled "A Landscape," where some of the bare facts of nature stand cold and

warped, while a Corot similarly named permits the imagination to dwell and appreciate the true facts and beauties, so the term "Cost System" is used to cover that situation where disconnected and unproved figures are used to determine policies where masses of figures unintelligent in their communications are collected, and every gradation up to that situation where the cost system with the minimum work illustrates clearly the changing conditions as a solid basis for action.

It is plain, then, that the executive needs a standard by which to gauge his cost system. But the standard is evident. It must present to him, in a proven way, the fair, complete costs of his units of production; it must tell the story of the use and waste of his materials; it must illustrate in operation and in groups the productivity of his labor; it must picture the values and returns, in units and by divisions of his expenses and their relations to labor operations and sales; it must marshal facts illustrative of the movements and relations of productions and sales, and of the changing situation as may be desired, or of the comparative values of methods; and it must do these things with the

minimum of time and exertion on the part of the executive, for too much cost system, too many figures, defeat the real purpose of cost, clogging action.

When it does these things with a fair readiness so that the business intelligence of the executive can grasp the truth (for let it not be forgotten that with all its possibilities the cost system is merely an inanimate record)—when it does these things, then, the executive has introduced into his business a moving-picture show of his manufacturing (more comprehensive than photography, which has its uses in this connection), comprehending a vision of the whole as well as of every part, and which can be run over again and again as he desires, and in comparisons.

When he has accomplished this introduction, the executive will have that which, with the aid of the philosophy of costs, will be a constant refining influence in his plant, will check, spur, and encourage his organization, will urge constantly, by showing value, improved methods. And his business will then be in possession of a right cost system—the basic improvement.

(The end)



FLOORS AND FLOOR CONSTRUCTION FOR MANUFACTURING PLANTS

By Henry Grattan Tyrrell

As indicated in the opening paragraph of this paper, Mr. Tyrrell's previous article, in the July issue, discussed materials available and construction specifications for ground floors. The present section is devoted to upper floor construction.—THE EDITORS.

IN a preceding article it was pointed out that floors for industrial buildings were divided into two general classes, ground floors and upper floors, some type being suitable only to the one situation and some exclusively applicable to the other. Note was made further that a distinction must be observed between the structural parts of the floor and the wearing surface, and the seven forms of flooring best suited to ground levels were described and illustrated. We come now to the subject of the second division—upper floors.

SLOW BURNING WOOD FLOORS

The essential principle of this type of construction is to use the smallest

number of large framing pieces, so that they may not easily be attacked by fire. It has been well proven by numerous fires that wood framing so arranged is a better fire risk than unprotected steel framing, which collapses quickly under heat.

Beams should not be closer than 5 to 10 feet apart, and the proper spacing may be found from the following table giving the required thickness of plank for various spans and loads.

Plank when laid flat should have tongue and groove for thicknesses of $2\frac{3}{4}$ inches or less, and for greater thicknesses, for economy, should be connected by splines. An excellent solid floor is obtained by placing

TABLE I.—SAFE LOADS IN POUNDS PER SQ. FT. FOR SPRUCE PLANK OF VARIOUS SPANS AND THICKNESSES, FOR LIMITED DEFLECTIONS

	Span in Feet										
Load per sq. ft. superficial.	4	5	6	7	8	9	10	11	12	13	14
30.....	0.9	1.2	1.4	1.7	1.9	2.1	2.4	2.6	2.8	3.1	3.4
40.....	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.0	3.2	3.5	3.8
50.....	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2
75.....	1.5	1.9	2.3	2.7	3.0	3.4	3.8	4.2	4.5	5.0	5.4
100.....	1.7	2.2	2.6	3.0	3.4	3.9	4.4	4.8	5.1	5.6	6.0
125.....	1.9	2.4	2.9	3.4	3.8	4.3	4.8	5.3	5.7		
150.....	2.1	2.6	3.1	3.7	4.2	4.7	5.2	5.7			
175.....	2.3	2.9	3.4	4.0	4.5	5.2	5.8				
200.....	2.4	3.0	3.6	4.2	4.8	5.4	6.0				
225.....	2.5	3.1	3.8	4.4	5.1	5.6					
250.....	2.7	3.3	4.0	4.7	5.4	6.0					
275.....	2.8	3.5	4.2	4.9	5.6						
300.....	2.9	3.6	4.4	5.2	5.9						
325.....	3.1	3.8	4.6	5.4	6.1						
350.....	3.2	4.0	4.8	5.6							
375.....	3.3	4.2	5.0	5.8							
400.....	3.4	4.3	5.1	6.0							

boards on edge, and spiking them together, the upper surface being covered with $\frac{1}{2}$ -inch tar mortar before laying the top course of boards. The mortar should consist of one part of tar with two parts of sand. Extra strength of continuity is secured by staggering the board joints, preferably at the point of contra-flexure, about one quarter way between the bearings. The best material for wood beams is hard or yellow pine. The lower corners should be chamfered, and in brick walls, beams should have cast-iron bearing plates with flanges,

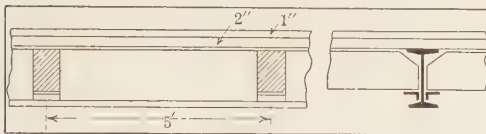


FIG. 17. SLOW-BURNING WOOD FLOOR

one to anchor them to the masonry, and another fitted into the beam. The upper end of the beams above the bearings should be mitered, to prevent inner leverage on the wall, in case the beams collapse by fire.

Wood floors should always have an upper wearing surface which can be removed as often as it becomes worn. Yellow pine is the best, though maple and oak are sometimes used. The edges were formerly matched or tongue and grooved, but owing to the difficulty of replacing this kind of floor, and its liability to splitting at the edge under trucks or other loads, square-edged flooring is now preferred. A thickness of $\frac{7}{8}$ inch is quite

as good as $1\frac{1}{8}$ inches, for when the floor is worn enough to need renewal of the thinner boards, the thicker board would also need renewal.

In order to prevent water from leaking through the floor, there should be two or three layers of tar or rosin paper between the upper and lower courses, and the last layer of paper should preferably be mopped with tar. Asbestos paper for this purpose has the additional advantage of being fireproof. Wood must remain unpainted until the timber is thoroughly seasoned, for if paint is applied too soon it only promotes decay.

The cost of wood floors with $\frac{7}{8}$ -inch maple over 3-inch plank on 8 by 12-inch yellow pine, 6 feet apart, is as follows:

TABLE II

	Per square
Wood beams.....	\$6.50
Iron stirrups.....	3.00
Anchors	2.50
3-in. plank.....	12.00
Paper	.50
Factory maple flooring.....	7.00
Total.....	\$31.50

The Sessions foundry at Bristol, Conn., has 3-inch tongue and groove yellow pine on 12 by 18-inch yellow pine beams, while a gallery floor in the Granger foundry at Providence, designed by me, has a double wood floor on 8 by 12-inch beams only 5 feet apart, supported on 12-inch steel beams. Figure 17.

These floors should be protected against fire by an adequate sprinkling system.

WOOD FLOORS WITH STEEL BEAMS

A low cost wood floor (Figure 18) which is lacking in fire-resisting qualities, is made by placing heavy wood joists, say 3 by 16-inch, 16 to 20 inches apart, which are supported on steel beams or riveted girders 10 to

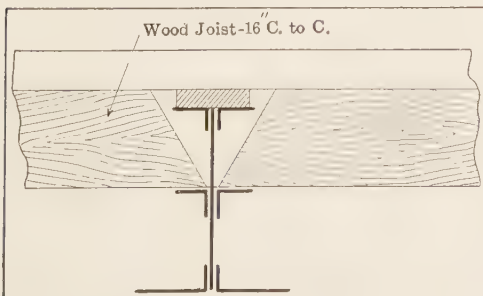


FIG. 18. WOOD FLOOR WITH STEEL BEAMS

15 feet on centers. The cost of wood work in the floor, with two layers of pine, $\frac{7}{8}$ and $2\frac{1}{2}$ inches, is 12 to 15 cents per square foot erected, not including any steel.

As framing timber is becoming more scarce every year, steel joists are often used instead of wood, and this type is now accepted by the insurance companies as a substitute for slow-burning wood construction.

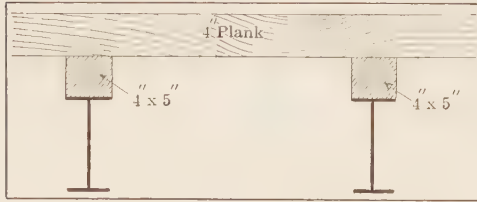


FIG. 19. WOOD-CAPPED STEEL JOISTS

Beam spacing in this type can be reduced to 3 or 4 feet with a corresponding reduction in the thickness of plank. The steel joists are capped with wood spiking pieces, about 4 by 5 inches, which are hook-bolted to the beams, Figure 19. The beams may be partially protected from fire by a suspended ceiling of expanded metal and plaster, and if extra fire precaution is needed, an upper wearing surface of asphalt may be used instead of wood.

TRIANGULAR SHEET STEEL FLOOR

Several forms of sheet-metal trough floors are available, most of them having the merit of maximum stiffness for the amount of material used. One of these, made in Ohio

and known as the Buckeye floor, has metal trough $2\frac{1}{2}$ inches deep, and including the concrete filling and $1\frac{1}{2}$ inch wearing surface, weighs about 35 pounds per square foot.

TABLE III.—WEIGHT OF GALVANIZED TRIANGULAR TROUGH FLOORING, $2\frac{1}{2}$ INCHES DEEP, IN POUNDS PER 100 Sq. Ft.

Gauge	Lb. per square
No. 16.....	386
18.....	313
20.....	241
22.....	204
24.....	168

The sheets are made in lengths up to 10 feet and in uniform widths of 21 inches.

Another excellent sheet-metal trough floor is that known as the Multiplex. The troughs are made of 2-inch uniform width, and depth of 2, $2\frac{1}{2}$, 3 and 4 inches, either painted or galvanized. Stock lengths vary anywhere from 5 to 10 feet, and gauge from No. 16 to No. 24. They are laid directly on the floor beams and are filled with concrete to a depth of 2 inches above the metal, but cannot be plastered on the under side and must be kept painted. If a wood wearing surface is desired, wood nailing strips must be embedded in the concrete above the metal, or these may be omitted and a granolithic surface used instead of the wood wearing surface.

METAL ARCHES

Arches of stiffened sheet metal between steel beams with concrete filling above them are extensively used.

TABLE IV.—SAFE LOADS ON MULTIPLEX STEEL FLOORS WITH CONCRETE FILLING 1 INCH ABOVE THE METAL

Metal Gauge	Depth	Weight	4 ft.	6 ft.	8 ft.	10 ft.
20	4	18	1260	550	300	185
24	"	17.3	792	352	198	127
20	$3\frac{1}{2}$	17.5	1115	485	265	165
24	"	16	720	320	180	115
20	3	15.3	970	420	230	145
24	"	14	550	244	137	88
20	$2\frac{1}{2}$	13.4	675	295	160	100
24	"	12.2	433	192	108	69

They have the objection common to all kinds of exposed metal, that they must be kept painted, or they will be destroyed by rust. No 18 gauge corrugated iron with a 10-inch rise, between beams 6 feet apart, has been tested with a load of 1,000 pounds per square foot, and for beam spacing of 9 feet, with 3 inches of concrete over the metal at the centre, it will safely carry a load of 200 pounds per square foot. The strength of this floor can be increased by making a greater crown thickness of concrete. It is, therefore, strong, apart from the filling above it, which, for the sake of lightness, is sometimes made of cinders. If cement-and-stone concrete is used instead of cinders, the strength is greatly increased. A floor of this kind, Figure 20, in an engine house designed by me cost 56 cents per square foot in place. Dove-tailed metal is sometimes used instead of corrugated iron, with the false impression that it can safely be plastered on the under side. This



FIG. 20. METAL ARCHES WITH CINDER FILLING

product offers insufficient grip to hold plaster, and a large building in which it was thus used was inspected by the writer after the plaster had fallen. The fall of so much heavy material not only injured the machinery and other contents of the building, but also endangered the lives of the workmen. No. 24 gauge dovetailed sheets cost \$8 to \$10 per 100 square feet at the place of manufacture, and weigh 163 pounds.

METAL-TROUGH FLOORS

A much stronger and heavier metal floor is obtained by using troughs made of rolled shapes riveted together. These are more used for

very heavy service, as on bridge floors, but are occasionally appropriate in buildings, Figure 21. The office of the Pencoyd Iron Works, having several floors, is made of Lindsay troughs painted a light blue on the under side. Floor sections made with sloping sides are liable to vary slightly in width when riveted, and it is therefore difficult to match the connecting holes in the supporting girders. For this reason, vertical sides are generally preferred. To

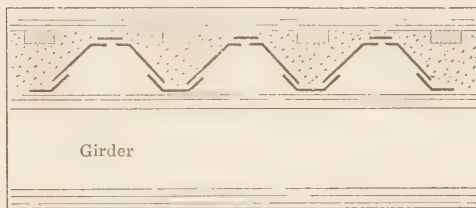


FIG. 21. RIVETED METAL-TROUGH FLOOR

economize in head room, the sections should rest on shelf angles, fastened to the girder webs rather than bearing on their upper flanges. Vertical troughs in small sizes are most conveniently made of Zs and plates, but for greater depths they are composed of plates and angles. Floor troughs vary in weight from 15 to 40 pounds per square foot, and tables of safe loads may be found in the handbook prepared and distributed by the Carnegie Steel Company.

PLATE FLOORS

Cast-iron or rolled-steel plates roughened on the upper side are much used in certain places exposed to fire, such as cupola floors, or around furnace openings. Rolled-steel plates are made in thicknesses of 5/16 inch to 1/2 inch, weighing 13.8 to 21.4 pounds per square foot. Cast-iron plates can be made heavier and stiffer than rolled ones and can be roughened enough on the surface to prevent men from slipping. They are extensively used in foundries and for charging floors.

BRICK-ARCH FLOORS

Brick or terra cotta arch floors are heavy and expensive and not well suited to factory buildings subject to jars and vibrations. The movement of heavy machines is liable to loosen the bricks and cause them to fall. Brick arches are laid in single rings 4 inches thick, on temporary wooden forms, the distance between beams not exceeding 4 to 5 feet, and the arch rise at least one-eighth of the span, Figure 22. The filling and floor

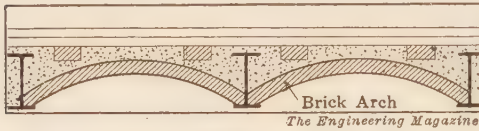


FIG. 22. BRICK-ARCH FLOOR

above the arch may be similar to that used in other arch forms, and concrete may be used for filling, with a finish either of wood boards on nailing strips, or granolithic.

CONCRETE FLOORS

Concrete floors are of three general kinds:

1. Those without slabs but with concrete beams and wood floors.
2. Those with concrete beams and slabs.
3. Those with flat concrete slabs only, supported directly on columns without beams.

The first of these types, with no slabs but with concrete beams supporting a double layer of floor planks, is very economical in cost. It is also lighter than a concrete floor, for while this material weighs 140 pounds per cubic foot, wood does not exceed 50 pounds. A four-story concrete office building in Massachusetts, with T beams without slabs and two layers of wood floor, cost with the equipment of lighting, heating, toilets, and partitions only 9.2 cents per cubic foot, or \$1.30 per square foot of floor area. Without equipment, the cost including foundation walls,

floors and roofs, was only 4½ cents per cubic foot, or \$0.63 per square foot of floor area. Wood nailing pieces were secured to each side of the concrete beams, and between it and the lower course of plank was a thin filling of cinders. A five-story concrete factory in the same state, 50 feet wide and 300 feet long, of the same general type as the last, cost without equipment only 7.6 cents per cubic foot, with a total saving of \$24,000 over a concrete design with beams and slabs.

A floor of the same type in a knitting mill in the central part of New York state cost:

	Cents per sq. ft.
2-in. hemlock plank.....	.07
Deadening felt.....	.005
⅞-in. floor and finish.....	.09
Plaster board.....	.025
Total.....	.19

For the same place a floor with reinforced-concrete slab and wood top, would have cost:

	Cents per sq. ft.
Reinforced-concrete slab.....	.40
Nailing strips in place.....	.03
Upper floor, finished.....	.09
Plaster under.....	.04
Total.....	.56

or about three times as much as that used.

FLOORS WITH BEAMS AND SLABS

This type constitutes by far the largest class of floors in concrete buildings. Apart from shop-made floor sections and joists there are many systems of monolithic beam and slab construction. A type which is quite economical is that used in buildings for the University of Wisconsin. For the purpose of forming ribs, inverted boxes were used instead of the usual forms, and they were so arranged as to make a system

of inverted beams and joists. These boxes were covered with sheet metal and were used thirty times or more. The total floor area in one building was 4,500 square feet, and provision was made for a live load of 200 pounds per square foot. The itemized cost of the building per square foot of floor was as follows:

	Cents per sq. ft.
Concrete	10.54
Reinforcing steel.....	7.86
Timber for supports.....	6.60
Wood boxes, 1/15 of cost.....	.72
Erecting supports and boxes.....	5.54
Placing concrete and reinforcement.	4.44
Removing supports and boxes.....	1.10
Total.....	36.80

A system of beams placed close together, with sloping sides, forming a heavy ribbed slab, was used in the balcony floor of a machine shop for the Fairbank-Morse Company at Toronto, Canada. The beams were 22 inches wide at the top and 6 inches at the bottom, and were placed 3 feet apart on centres, each beam being reinforced with six rods, 11/16-inch diameter. A roof over the gallery was of the same general type, with a 3-inch slab on beams of the same size placed 8 feet apart. The tendency, however, in recent years is to use heavier slabs and fewer beams, and it is now common to find beams 16 to 20 feet apart at the columns only, without intermediate joists.

Slabs may be supported at all four sides or at two sides only, the first being the strongest and most economical arrangement. With four side supports, the reinforcing steel will lie in two directions at right angles to each other, and for economy the slabs should be continuous over their supports. Another economical plan is to use slabs 8 to 12 feet long, supported on lines of beams resting directly on the columns without joists

or cross girders. Roof framing is usually made of the same dimensions as the floors, for extra stories can then be added if desired, without removing the roof or strengthening it. In some cases, however, as in the machine shop at Toronto, mentioned above, the roof framing is made lighter than the floor.

Wire mesh or expanded metal is more convenient for slab reinforcement than loose bars, for it is made at a factory and can be spread out in sheets. No. 10 gauge expanded metal with 4-inch mesh is often used and costs about \$3.50 per 100 square feet. Reinforcing metal in slabs generally costs 3½ to 4½ cents per square foot of floors when designed for a live load of 100 pounds per foot. Wire is economical because of its high tensile strength. Triangular mesh with strands of No. 4 wire, 4¼ inches apart, united by a weave of lighter wire, weighs 57 pounds per 100 square feet and costs generally about \$2.30 at the mill. It is shipped in rolls up to 58 inches in width and 600 feet in length.

Concrete slabs may have wearing surfaces of granolithic, boards, or asphalt. A granolithic surface, as previously described under "Ground Floors" is by far the cheapest though uncomfortable to walk upon. When a wood floor is laid over a concrete slab, the slab should first be covered with two layers of tar felt or heavy paper in pitch, or the lower course of plank may be bedded on tarred sand as was done in the Blake and Johnson factory at Waterbury, Conn. A shop at Woonsocket, designed by Mr. F. W. Dean, has nailing strips built into the 6-inch concrete slab, and to this is spiked a lower course of 3-inch plank which is covered with 7/8-inch maple. The screeds should be creosoted or coated with tar to prevent dry rot. Assuming

average conditions and markets, matched factory maple flooring $\frac{7}{8}$ -inch thick over 2-inch spruce costs 13 cents per square foot, and $\frac{7}{8}$ -inch yellow pine over 2-inch spruce costs 9 cents per square foot. Nailing strips or sleepers cost 4 cents per lineal foot in place, and 2 to 3-inch cinder fill between the strips costs 3 to 4 cents per square foot.

An asphalt wearing surface is both lighter and cheaper than wood. The concrete should first be washed with a mixture of melted tar and asphalt having just enough asphalt to make it hard when cold. The asphalt should be spread 1-inch thick and rubbed smooth with sand, as described under ground floors. A car shed in Jersey City, designed by Mr. J. B. French, has a 4-inch roof slab of cinder concrete, reinforced with No. 23 triangular mesh.

Original and simple formulæ for proportioning concrete slabs are given herewith:

$$D = \sqrt{\frac{M}{1,000}} \quad A = \frac{D}{12}$$

In which D is the depth of slab in inches from the upper surface to the centre of the rods; M is the bending moment in inch-pounds per foot width of slab; A the area of steel in square inches per foot of width.

The cost of reinforced-concrete floors and framing under average conditions is as follows:

Floor slabs and beams without columns.....	35 to 45 cents per sq. ft.
Complete reinforced concrete frames without walls.....	50 to 65 " " "
Labor of mixing and placing concrete.....	\$1.00 to \$1.50 per cu. yd.
Total cost of concrete in place.....	\$6.00 " "
Total cost of concrete in place, including steel.....	\$12.00 " "
Forms and scaffolding.....	\$5.00 " "
Total cost of concrete, steel and forms.....	\$17.00 " "
Cinder filling 3 inches thick over slabs.....	4 cents per sq. ft.
" " 1½ to 2 inches thick.....	3 " " "

Plain rods cost \$30.00 per ton, while patent or deformed ones usually sell for \$40.00 to \$45.00 per ton. The concrete in the floors of a large build-

ing in Kansas City in 1908, was laid at the rate of 50 cubic feet per man per day. Under less efficient management, it had formerly been placed at only half that rate.

The weight of various concrete floor systems varies from 60 to 120 pounds per square foot, including the steel, which for the floor only is from 2½ to 6 pounds per square foot. Dry cinder concrete weighs from 50 to 75 pounds per cubic foot. The weight of floors depends, therefore, on the system used, the kind of material, and their carrying capacity.

FLAT SLAB FLOORS

Floors with flat ceilings have some advantages over those with exposed ribs or beams underneath. In case of fire, jets of water from fire hose or sprinkler systems are less obstructed on flat ceilings than when beams are used, and light is also better diffused. Shafting and sprinkler heads are more easily attached to flat surfaces than to those broken up with beams, the saving in these items amounting in some cases to 25 per cent of the cost of installation. Forms or false work for flat ceilings cost 5 to 8 cents less per square foot when beams are omitted. A flat surface can, of course, be made by suspending a ceiling of expanded metal and plaster below the floor beams, but this not only incurs extra expense for the ceiling itself, but it is no saving either

in the height of the building or in the cost of forms. Another common method is that in which hollow terra cotta tiles are placed between floor

joists with comparatively close spacing. While this method reduces the cost of centering, it saves nothing in the floor thickness and includes the additional cost of tiles. Besides the tiles are liable to crack and fall from the jars and vibration of machinery, exposing the building contents and the workmen to danger.

Floors with solid slabs without beams have a less total thickness than the combined depth of slab and beams, and the available head room in a story is correspondingly greater. Or if a fixed clear story height is needed, the total height of a building with flat slabs can be less than with slabs and beams. In a ten-story building with beams 16-inches deep, the total saving in the building height by using slab floors would be from 10 to 12 feet.

The chief objection to solid slabs supported directly on columns without beams is their uncertain stress conditions. For fifty years or more, structural engineers have wrestled with the problems of uncertain stress. The merit of continuous girders, multiple truss systems, and other uncertain types have long been appreciated, and yet the uncertainty of their stresses has gradually but surely relegated nearly all such systems to oblivion. One of these flat-slab systems with the floor supported by bars radiating from the column tops at the four corners is suitable for column spacing not exceeding 20 feet. Floor panels 16-foot square with a 7½-inch rough slab not including the 1¾-inch strip filling, will sustain a safe test of 800 pounds per square foot. Larger panels, 17-foot square with a rough slab thickness of 9½ inches and a concrete unit stress of 800 pounds per square inch, is strong enough for a live load of 200 pounds per square foot, with 11½ per cent of steel reinforcement at the

top and bottom of the slab. If 11½ per cent of steel is used at the top only, the required thickness of rough slab would then be 12 inches. This type requires about 40 per cent more steel than floors with beams and thinner slabs, but the difference is partly offset by the lower cost of centering.

TABLE V.—THICKNESS OF FLAT REINFORCED-CONCRETE FLOOR SLABS SUPPORTED AT THE FOUR CORNERS ONLY

Span ft.	Total load per sq. ft., lb.	Slab thick- ness, in.
12	100	4
	300	6
	500	7½
14	100	4½
	300	6½
	500	7½
16	100	5
	300	7
	500	8
18	100	5½
	300	7½
	500	9
20	100	6
	300	8
	500	10
25	100	7
	300	10
	500	11

In order to determine the comparative cost of reinforced-concrete buildings with flat slab floors, and with floors of combined beams and slabs, estimates were made on a ten-story building 109 feet wide and 580 feet long, which showed that the design with flat floor slabs, including a patent royalty of 1½ per cent, had a cost only 2 per cent less than the design with slabs and beams.

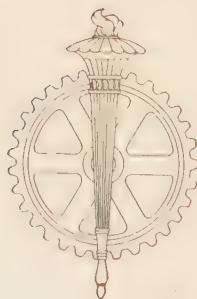
The itemized cost of concrete per cubic yard, of 1-2-4 mixture, was as follows:

Concrete, 1 2/3 barrels @ \$1.10.....	\$1.80
Sand, 1/2 yard.....	.40
Stone, 1 yard.....	1.00
Labor	1.00
Sundries	.10
Total.....	\$4.30

Concrete in columns had an additional cost for labor of 70 cents per cubic yard.

It is well known that flat slabs supported only by columns at the four corners are not subject to exact analysis and are proportioned chiefly from experiments, though the slabs are sometimes assumed to act as cantilevers from the flaring column heads. This condition in itself should give the preference to other and better forms which can be proportioned with certainty. Fortunately such forms are available, for slabs with reinforcement in two directions may be supported on other wide and shallow slabs or beams continuous over the columns, forming large panels in

the ceiling, corresponding with the position of the columns. The æsthetic effect of these panels is much superior to a wholly flat surface, and the type is by far the best yet available. In the Sharpless building in Chicago, with columns about 18 feet apart, the main beams are 6 feet wide and only 1 foot deep, with an 8-inch intermediate slab, the weight of steel in the floor being $5\frac{1}{2}$ pounds per square foot. Columns have a uniform diameter of 2 feet from the basement to the tenth floor, the column caps under each floor having a diameter of 4 feet. A similar arrangement is used in the Studebaker building in Chicago in which the columns are 24 feet apart.



THE ELEMENTS OF FACTORY FIRE-PROTECTION

By Ira H. Woolson

We have committed to Professor Woolson the pleasant office of introducing Mr. Walther's excellent discussion of fire-resisting construction. The first of Mr. Walther's articles follows immediately Professor Woolson's introduction. The second will appear next month.—THE EDITORS.

ACCORDING to the best obtainable statistics, the fire loss in the United States for the year 1911 was \$217,004,575; \$70,000,000, or over one-third of this colossal waste, was due to the burning of factory buildings. Think of it! The manufacturers of this country annually throwing away one-tenth as much as it takes to support this great extravagant government, including the vast expenditures for the pension fund, support of the army and navy, and the appropriations for the Panama Canal, with all the other thousands of demands upon the country's exchequer.

It is difficult to understand how sensible business men who labor hard the year round to advance their commercial interests, and are keen to grasp every opportunity to save a dollar, will calmly sit by and permit this profligate annual waste with scarcely a protest. We are forced to the conclusion that our major premise was not true. They are not sensible men! If they were, they would be prompt to reduce this fire loss.

The American people have become so accustomed to fires that they accept them without question as a sort of necessary evil. The situation is analagous to that which existed in regard to smallpox two hundred years ago. The people dread the plague, but continue to permit habits which favor its occurrence, unmindful or ignorant

of the fact that the remedy lies within their own hands.

The folly—I might more rightly say the crime—of the condition, so far as factories are concerned, is that probably no class of buildings is more easily or surely protected against the spread of fire. The facts that they are built for a specific purpose, and therefore can be planned with considerable precision; that they are constantly under the supervision of intelligent men; that the hazard of their contents is fully understood in each case; and that the capital involved in the business is usually large, and would well warrant a comparatively small additional investment to protect it, are a few of many reasons why this annual loss of \$70,000,000 should be stopped. That it can be checked, is proven by the experience of the Factory Mutual Insurance Companies of New England, who by their rigid requirements and inspections have reduced their fire loss during the past fifteen years most remarkably. Carrying during that period an average risk of \$1,200,000,000, they had only eight fires exceeding in value \$100,000 each, and three of the largest resulted from violation of established rules. This experience over so wide a field for that period of time is conclusive evidence that the factory fire hazard is controllable.

Strictly fireproof factory buildings,

complete with elevators, plumbing, electric wiring and steam heating, can be erected today, in favorable localities at a cost of 10 to 15 cents per cubic foot of contents. Good structures with a moderate fire-resisting value can be built for considerably less. At these prices, however, the best should be none too good.

Those who have studied the problem of factory protection are agreed that the chief factors in it are: Fire-proof or slow-burning construction. Elimination of vertical openings. Restriction of large areas by fire walls. Protection of window openings by metal sash and wired glass. Installation of automatic sprinklers. The Factory Mutuals claim that they "have never had a fire get beyond control where there was a good sprinkler system supplied with ample water at good pressure, and with the water on when the fire started." This statement is worthy of the most serious consideration by factory owners.

There are many minor factors in the problem which with these will be discussed in Mr. Walther's valuable papers, and it is hoped they may awaken a widespread interest.

I must not close without a word upon one more most vital point in reference to safe factory construction—namely, protection of human life. This should be the first consideration in factory planning.

Certain provisions for the protection of the lives of factory operatives should be made mandatory by law, irrespective of the factory owner's willingness to protect his property.

Among these essentials are the organization of fire drills, the installation of smokeproof stair towers, and fire division partitions, the main object of the latter being to check a fire temporarily for a half hour or so. Operatives can pass through them in safety and have ample opportunity to escape by other exits. These partitions, if desired, can be half wired glass, thus permitting an unobstructed view of the whole floor. Lastly, I wish to register a strong protest against the tendency in all large cities to erect excessively high factories. They are entirely unnecessary, and always a menace to human life under the most favorable conditions. The height of factory buildings should never exceed six stories.

PRINCIPLES OF FIRE-RESISTING CONSTRUCTION FOR INDUSTRIAL PLANTS

By F. P. Walther

ONE reads with alarming frequency in the daily press accounts of manufacturing plants having been totally destroyed or badly damaged by fire. Why is it that the fire so frequently totally destroys the plant, or the statement can be made that "the fire spread so rapidly that it was beyond control before the fire-fighting equipment could be gotten into action?"

It is primarily because little or no

attention was paid in the construction and arrangement of the plant to prevent just such an occurrence. Every effort may be made to eliminate the chances of fires starting, and sufficient apparatus may be provided to handle ordinary fires, but as long as the construction of the building is defective—that is, such as not to offer resistance structurally to the spread of fire—a fire starting under even moderately adverse



A CASE OF INSUFFICIENT PROTECTION FROM EXPOSURE
Courtesy of Insurance Engineering

conditions may and probably will mean the total destruction of the plant. In the designing of a plant considerable time and thought is given to its arrangement from the standpoint of its commercial use. It is of greater importance to study means of ensuring its continued use, or in other words, to study means of preventing its destruction by fire.

If neglect of the fire danger concerned only the interests directly involved it would be bad enough. But too often a fire, starting even from insignificant causes, sweeping rapidly through a building which structurally offers no impediment to its spread, quickly reaches such intensity that it easily involves other similarly weak structures and a conflagration results. In Chelsea, Massachusetts, in 1908, a fire, originating perhaps by the dropping of a cigarette, quickly spread to nearby frame warehouses. Before this fire was brought under control it devastated 275 acres and caused a fire loss of \$12,000,000. In Jacksonville, Florida, in 1901, a fire started in some moss in the yard of a mattress factory on the outskirts of the city. The firemen had the fire all out when

the wind caught up some of the burning moss. These flying brands spread the fire with almost incredible swiftness and the business district was soon involved. The property loss in this case was \$11,000,000. Again, just this year, in Houston, Texas, a manufacturing plant, of poor construction, caught fire from a burning untenanted rooming house across the street. This fire, fanned by a high wind, burned over a strip about $1\frac{1}{2}$ miles long by 200 yards to $\frac{1}{2}$ -mile wide, consisting of railroad yards and a scattering of lightly constructed manufacturing plants, cotton compresses, and dwellings, with a resultant property loss of \$4,000,000. Other conflagrations have had similar histories; that is, they encountered nothing structurally to resist their spread and literally burned themselves out.

The proper construction of buildings, therefore, concerns not only the builder but also the community at large. In some of the European countries a person is held responsible for damage done to neighboring property by a fire originating in his premises. The value of such a law is apparent, and it is but a question



RESULTS OF UNPROTECTED FLOOR OPENINGS

Above, a poorly enclosed stairway has formed a regular flue for spreading the fire. Below, an open elevator in a fireproof building has brought complete destruction to the contents



POOR SECTIONAL CUT-OFFS. FAILURE OF NON-STANDARD FIRE DOORS

Note holes in division walls where timbers in adjoining fire sections abutted

of time before this country also will hold the individual responsible.

It is only of recent years that the arrangement and construction of manufacturing plants from the standpoint of preventing the spread of fires has received practically any general attention. This is largely ascribable to a lack of appreciation of the importance of the subject, to the additional expense involved, and to a false idea that the necessary arrangement of a building to safeguard the fire hazard is not conducive to its economical commercial use.

Everyone is familiar with the old-style department store with its open stairs and elevators and huge open light well extending from the ground to the roof, constituting regular flues

or chimneys for intensifying and spreading fire with great rapidity. A better arrangement to secure the total destruction of the building in the event of fire could hardly be made if the building were designed for the particular purpose. That there has never been a holocaust in one of these veritable firetraps is nothing short of a miracle. When it was first suggested that the stairs and elevators should be placed in fireproof enclosures and the light wells eliminated, or properly enclosed, the managers literally held up their hands in horror and declared that to have them open was absolutely indispensable to the proper conduct of their business. It was thought that an open view of the floors as

the people passed up and down and the extra light from an unobstructed light well were essential. That the managers have realized the fallacy of this is shown by the fact that to-day all over the country department stores are being erected with well cut-off floors. It is certainly little short of criminal to build otherwise when lives are endangered.

Likewise, if the managers of manufacturing plants will give the fire hazard earnest consideration they also will find that it is not only practicable, but that it more than repays them, to take the fire hazard into consideration and to adopt every means known to modern science to

because it is possible to carry insurance covering not only the actual property loss by fire, but also the loss of profits, rents, or the use and occupancy of the plant while it is being reconstructed, the monetary loss is slight. That this is a widespread general belief is evidenced by the statement frequently made that the destroyed plant was fully insured, implying thereby that the loss is negligible, whereas if only partial insurance is carried the fire is referred to as a calamity. One also frequently hears the (jocular) remark that the destroyed plant was "sold out" to the insurance companies.



A NON-STANDARD FIRE DOOR WHICH WITHSTOOD THE FIRE, BUT ALLOWED IT TO GET THROUGH BECAUSE OF INSUFFICIENT OVERLAP

guard against the possible devastation of their plant.

Another false but very common belief that has greatly interfered with the proper consideration of the fire hazard by the man about to build a plant has been the idea that

In the first place, the idea that because the insurance companies reimburse the sufferers from fire there has been no loss does not take into consideration the fact that property burned without doing useful work is just so much of the material wealth



OF THE EQUITABLE BUILDING, SHOWING
On the left, looking across the main collapse.



THE RESULT OF UNPROTECTED FLOOR OPENINGS
On the right, an interior view, looking down

of the country irretrievably lost. The insurance companies merely act as distributors, collecting small sums from the many and paying out large sums to the comparatively few sufferers from fire. They do not create new wealth to take the place of that burned up.

In the second place, the numerous annoyances, interruptions to business, loss of trade, etc., which are the accompaniments of a fire, cannot be covered by an insurance policy. If this could be figured in dollars and cents it would be seen to represent a considerable sum. I have often been told by people who have had their plants destroyed that they have been put back in their business progress from one to five years. No argument is needed to induce these people to adopt all practical safeguards against fire; few people who have been through a fire care to repeat the experience.

In the third place, owing to the excessive annual destruction by fire in the United States (in a normal year nearly \$250,000,000 worth of property is burned), rates of insurance on the average manufacturing plant are of necessity high and often constitute a serious maintenance charge against the plant. The insurance companies are not philanthropic institutions, and in order to remain solvent must collect enough to cover the losses incurred and the expense of conducting their business. When it is fully realized that every fire has its proportional effect on insurance rates, and therefore on the pocket-book of every person carrying insurance on similar property, it will be seen that the subject of fire prevention is of vital individual interest. So thoroughly do the insurance companies appreciate the great value of well constructed and safeguarded buildings that they are today making large concessions in

rates on such buildings. It is rapidly becoming false economy to build otherwise. But if there is to be any sane reduction in insurance rates, the rate of burning must be decreased, and this can best be accomplished through proper construction, equipment, and maintenance of buildings, a matter which is in the hands of the insuring public.

Furthermore, the present weak building construction and the resultant chances for disastrous fires require the maintenance of excessively large public fire departments and water supplies, and the heavy cost of these constitutes a serious tax which must be added to the fire cost, but is seldom taken into consideration by the manufacturer. In some of the larger cities the maintenance of the fire department alone amounts to more than \$2 per capita. The total annual cost of maintaining public fire departments throughout the country, and the necessary extra water supplies for fighting fires, has been placed by the United States Government at the astounding figure of \$300,000,000.

Still another aspect which is often overlooked but which nevertheless adds its quota of importance to the guarding of the fire hazard is the feeling of security which the good plant gives the owner or manager. The full import of this will be best realized by those who have had fire-traps and have subsequently built well constructed and safeguarded plants. A self-analysis would show that the feeling of security as contrasted with the former nightmare of never knowing when they went home at night whether their plant would still be in existence the next morning, is worth considerable. Too often safeguards from fire are looked at only from the extremely narrow view of whether the saving in premium will pay for the improvement.

In planning the construction of a manufacturing plant with the idea of controlling the fire hazard there are three distinct phases to be considered. First, the arrangement of the plant to prevent the sweeping fire, second the proper construction of its parts, and third, the necessary equipment to combat any fire which may occur. We will consider first the proper arrangement of the plant.

It is self-evident that a plant which consists of a number of buildings, no one of which contains a large proportion of the total values, and so separated from each other that no two are likely to become involved in the same fire, constitutes the best fire risk. It is the arrangement which should be made whenever feasible. Unfortunately, the high cost of land, or other considerations, frequently make it impracticable to separate the buildings properly, if indeed they can be separated at all. In cases where buildings must be erected with only a moderate degree of separation, less than 50 feet between them, all exposed window openings should be so well protected that the burning of one building will not involve any of the others. Where the buildings necessarily adjoin each other they should be separated by substantial fire walls, without openings whenever possible. And when the individual buildings are of large size they should be subdivided into sections by means of dividing fire walls.

Many factory owners take a pride in a large expanse of floor area; but large areas are a prolific cause of destructive fires, since they permit fires of such magnitude as to overtax the fire-fighting facilities, and should be shunned like a plague. The old saying that it is foolish to put all of one's eggs in one basket holds especially true in industrial plant design. The more sections the plant is

divided into, or conversely, the smaller the areas of the sections, the more chance there will be of controlling a fire. As a general proposition no one fire section should exceed 10,000 square feet in area.

The proper subdivision of a plant not only takes into consideration the question of size of the individual buildings or sections; it entails a study of the particular fire hazards of the processes to be carried on. Experience has shown that there are certain manufacturing processes which are the frequent cause of fires. In a well arranged plant these will be placed in isolated buildings, or else in well cut-off sections, depending upon the seriousness of the hazard. The permissible size of the building or section is governed by the dangers involved. It should always be remembered, and it cannot be too strongly emphasized, that the smaller the section or building containing this danger-involving process, the better will be the outcome in case of accident. The best rule to follow is to make the sections as small as practicable.

Perhaps the best example of the value of making a study of the fire hazard that could be given is that of the textile industry. In the early days of this industry the mills were frequently totally destroyed. The fire record was so bad that the insurance companies did not care to insure them and the rates were very high. This finally impressed the more progressive of the mill owners with the fact that drastic steps were necessary to reduce the enormous drain on their resources. A systematic study of the fires showed that the most dangerous process was that of picking.

For the benefit of those who may not be familiar with the picking process, it may be stated that a picker, in its simplest form, consists es-

entially of a drum which revolves rapidly and has on its periphery numerous prongs which mesh with other prongs in the stationary part of the machine. When the cotton is fed into the machine it is "picked" by these prongs. It frequently happens that nails or other foreign materials become mixed with the cotton. When the rapidly moving prongs strike this substance sparks are emitted and these ignite the highly inflammable cotton.

In the early cotton mills the picking process was carried on right in the main building. As it is practically impossible to eliminate the danger of foreign substances being in the cotton bale, it was recognized that the next best thing to do was to segregate the picking hazard. So in all modern mills the picking is done in a well cut-off section. Profiting by this lesson, learned in the extremely expensive school of actual experience with fires, the mill owners made a further study of their processes and added other safeguards as their need was determined, so that today few cotton mills burn up, and the insurance rate is a mere fraction of what it formerly was.

In the same manner, the fire records of other industries indicate their dangerous features, and by studying these records it may be readily seen what processes should be carried on in separate buildings. For example, gasoline and naphtha are very dangerous, but commonly used substances, and where employed in any but very small quantities, either undiluted or mixed with other materials, their use should be confined to small sections, preferably detached from other buildings. As the insurance companies are continually analyzing the fire hazards of a vast number of plants and are amassing a large

amount of information, a wise manufacturer will draw upon this source of information and profit by the experience of others.

In the subdivision of a plant into sections the proper construction of the dividing walls is of first importance. To be effective the walls must conform to certain well-defined principles or else a fire will get through or around them. Fire walls must be of brick or other material capable of withstanding a severe fire for a considerable time, must be of substantial construction and must extend above the roof. If a fire wall is not of heavy construction it is likely to buckle and collapse. If it does not extend above the roof sufficiently, flames will lap across it and ignite the adjoining roof. The minimum permissible thickness of a fire wall is 12 inches; 16 inches is much better, and the least height it should extend above the roof is 3 feet. If there are wooden cornices or eave boards the fire walls must be extended out to form effective cut-offs at these points. If the building being subdivided has wooden side walls the fire wall should extend at least 3 feet beyond the frame walls or else have brick wing walls substituted for the frame walls for at least 3 feet on either side. Wooden timbers should preferably rest on a ledge or corbel instead of entering into a fire wall, but when the timbers do enter such a wall they should be separated from the opposite side, or from timbers entering the wall from the opposite side, by at least 8 inches of solid masonry.

Fire walls should be blank whenever possible. When openings are necessary to afford communication from one section or building to another, the openings should be protected by fire doors on each side of the wall. The double doors are essential because the door on the fire



RUINS OF LEO PAPER-BOX FACTORY. THE DEPARTMENT WAS BUSY FIGHTING ANOTHER BIG FIRE
Courtesy of Insurance Engineering

side of the wall is apt to become impaired, but the one on the other side, if properly constructed, will in all probability hold up and keep the fire out.

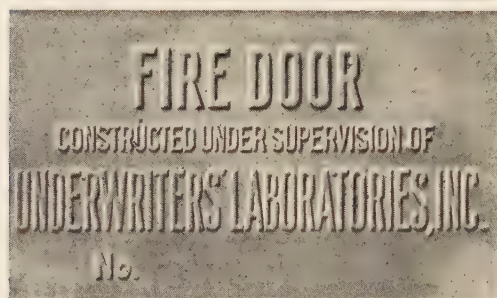
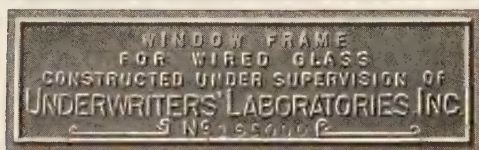
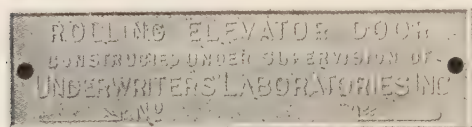
The early types of fire doors consisted merely of tin tacked on both sides of a wooden door, with the edges generally exposed, or of a thin sheet of iron, somewhat reinforced by light bands. The tin covering on these doors peeled off when it became slightly heated, and the iron doors warped and let the fire through. Today the tin-clad door has the wooden core effectively enveloped with tin put on with locked joints and in such a manner that none of the nail heads are exposed. The wooden core is frequently entirely consumed, but the joints of the metal cladding hold and the door fulfils its purpose. A good ex-

ample of a modern iron door consists of a heavy iron plate well reinforced or braced by an angle iron framing instead of the flat bands formerly used. This door has also given good accounts of itself.

The method of hanging doors, the attachment of the hardware or fittings, the construction of the sills, and the framing for the door opening are all important subjects. A neglect or slighting of any one may mean the failure of the door in time of need.

The matter of fire-door construction has been made the subject of careful study by the insurance interests, both in actual fires and through laboratory tests. As a result of these investigations a set of specifications for the proper construction and installation of fire doors has been adopted. While the mill owner can

and ought to obtain a copy of these specifications, experience has shown that the making of the doors is a trade in itself, and it is therefore strongly advised that the doors be purchased from some firm making a specialty of them.



LABELS FROM THE UNDERWRITERS' LABORATORIES, INC., GUARANTEEING STANDARD CONSTRUCTION

The stock insurance companies, through an organization known as the Underwriters' Laboratories, Inc., located in Chicago, maintain a labeling service whereby doors which have been constructed in accordance with their specifications bear a distinctive label. Before a manufacturer may apply this label, sample doors, usually obtained in the open market, are given a thorough fire test at the laboratories, and subsequently the factory is frequently visited by a laboratory representative to see that the specifications are being adhered to, branch offices being maintained all over the country for this purpose. The presence of this label guarantees that the door has been constructed in a proper manner.

The construction of a fire door and

its installation may be standard in every way, but for the door to be of service it must be closed at the time of fire. As employees of a plant cannot always be depended upon to close the doors that may be left open during the operation of the plant, because of panic or other reasons, fire doors should be either self-closing or automatic. A self-closing door is one which closes by itself as soon as a person has passed through. This door is normally always closed and never should be allowed to be blocked open. The automatic type is held open by means of a weight or catch, which has connected with it a series of fusible links. In case of fire the solder on one or more of the fusible links melts from the heat, releases the weight or catch, and the door closes automatically. This type of door should be employed wherever it is necessary for the door to be kept open at times, but otherwise, the self-closing door is preferable.

As has been previously mentioned, all window openings throughout the plant which are within 50 feet of an exposure should be protected. Common practice is to protect windows only against exposures within 30 feet, but the fire record shows this to be inadequate; severe exposures, even when at greater distances than 50 feet, should be protected against. The efficiency of what are otherwise good fire walls has often been spoiled by two sections of a plant meeting at an angle and having unprotected window openings in each wall forming the angle.

It may be stated that a frame building constitutes a much more dangerous exposure than a brick building of even larger size, as, in addition to the larger amount of combustible material, in the burning of a frame building there is nothing to prevent the horizontal radiation

of heat, whereas brick walls tend to deflect the heat upward. Also, the exposure from a low building to a taller one may be more serious than that between two brick buildings of equal height; this is due to the natural upward trend of the flames and hot gases. Therefore in protecting against exposures the general layout of the plant and its surroundings require careful consideration.

the wire is to hold the glass in place should it become cracked by the heat. The frames for holding wired glass to be effective must be of metal and so constructed that they will not fail under severe heat. After much testing a satisfactory frame has been developed, and any window which bears the Underwriters' Laboratories' label may be relied upon to do its work. Wired-



TESTING FURNACE, UNDERWRITERS' LABORATORIES, CHICAGO, FOR TESTING FIRE DOORS, SHUTTERS, ETC.

There are four types of window opening protection in general use, namely, tin-clad shutters, iron shutters, wired glass with metal frames, and water curtains. The principles involved in the construction and installation of tin-clad and iron shutters are practically the same as for fire-door construction, previously mentioned.

Wired glass is a glass which has embedded in it a woven wire with about a 1-inch mesh. The object of

glass windows have the great advantage of always being in place and well maintained, as they are an integral part of the building, whereas shutters, if not closely watched, are subject to neglect, involve the added labor of opening and closing each day, and therefore are more than likely to be out of order or open in time of need; also, a quick fire may make it impossible to close shutters in time. Wired glass has the added advantage of permitting



SHOWING, BOTH BY FAILURE AND SUCCESS, THE IMPORTANCE OF WINDOW-OPENING PROTECTION

Note on the left, the failure of both glass and ribs of improperly constructed windows. On the right, both buildings forming the angle have been saved by proper protection. Otherwise they would have been involved in the fire which destroyed the shed

a fire to be seen from the outside, but it has the serious drawback of being incapable of stopping radiated heat, so that any inflammable stock within a few feet of a wired-glass window is in danger of being ignited and great care must be taken to keep such stock away from it. In important buildings, and where the exposure is serious, this defect is overcome by the additional employment of one of the other forms of window-opening protection, frequently the water curtain.

The first water curtains consisted merely of perforated pipes installed either at the eaves or along the ridge of the building. When turned on a sheet of water would flow down the roof and side of the building. It was soon discovered that in order to make the water curtain really effective it was necessary to spray the water onto the surface to be protected, as heat waves pass right through a sheet of water as through a glass window. So modern water-curtain equipments are spe-



AT WORK THE DAY AFTER A SEVERE FIRE IN THE ADJOINING BUILDING
The holes in the wired glass windows were made by the firemen to fight the fire from this vantage point.



STANDARD WIRED GLASS WINDOW-OPENING PROTECTION, AIDED BY AN AUTOMATIC SPRINKLER SYSTEM, SAVED THE LARGE BUILDING AND PROBABLY PREVENTED A CONFLAGRATION

cially designed to throw all of the water on the surface to be cooled. In place of the perforated pipes open sprinkler heads are now generally

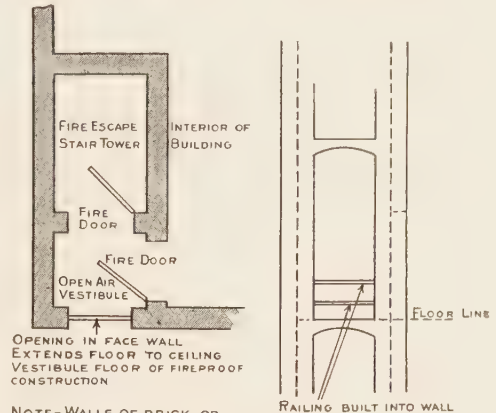
used, these heads being usually placed at the window openings only. One of the greatest drawbacks of a water curtain is the large amount of

water needed to supply it properly. This may be offset in a degree by dividing the system into small units by means of easily accessible valves so that only that part exposed by the fire need be used.

A close student of fires cannot help but notice the frequency with which buildings having unprotected floor openings are completely gutted by fire, even in cities having the best of fire departments and water supplies. The reason is easily found. The stairs and elevators form regular chimneys which suck the fire upward and allow it to honeycomb throughout the building. If there is any delay in the discovery of the fire, and consequently in the arrival of the fire department (a common occurrence) such a building is usually doomed. The many repetitions of bad fires traceable directly to this cause are forcibly, if gradually, bringing home to everyone, the layman, architect, and insurance man alike, that it is absolutely necessary to separate one floor from another by effective floor cut-offs.

The generally accepted theory of the start of the Baltimore conflagration is that unconsumed hot gases from a smoldering fire in a basement passed up through unprotected floor openings and spread throughout the upper floors of the building. Upon ignition of these gases there was an explosion (ordinarily spoken of by firemen as a "back-draft"), which spread the fire with such rapidity that it was almost immediately beyond the control of the fire department. The reader in watching fires probably has noticed the sudden bursts of flames in the smoke clouds. These are merely due to the unconsumed hot gases becoming sufficiently mixed with oxygen to make them burnable. When this occurs in a confined space an explosive mixture is formed, and upon ignition the ex-

plosion occurs. Just recently a smoke explosion in a burning paper warehouse in Cleveland, Ohio, had sufficient force to throw out the rear wall. In the Baltimore conflagration it hurled the fire across the adjacent streets. By properly protecting floor openings, the danger of a serious explosion occurring is largely reduced.

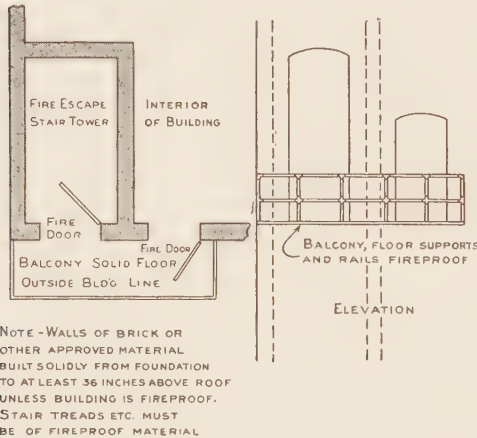


NOTE—WALLS OF BRICK OR OTHER APPROVED MATERIAL BUILT SOLIDLY FROM FOUNDATIONS TO AT LEAST 36 INCHES ABOVE ROOF UNLESS BUILDING IS FIREPROOF. STAIR TREADS ETC. MUST BE OF FIREPROOF MATERIAL

STAIR TOWER WITH OUTSIDE VESTIBULE ENTRANCE
The figures on this page and page 736 show the best types of stair enclosure, avoiding direct communication with buildings as approved by the New York Board of Fire Underwriters

Had the floor openings been properly protected in the building in which the Baltimore conflagration started, in all probability there would not have been that conflagration, with its many millions of property loss, since the firemen arrived at that fire before any flames were visible. Had the supposedly fireproof Asch building in New York City been so equipped the recent fire which caused the death of one hundred and forty-five persons would not now be a matter of history. The Equitable building, also in New York City, a semi-fireproof structure, which was completely gutted by fire on January 9, 1912, entailing a property loss of several millions of dollars in the single structure and

making inaccessible for a time over a billion dollars worth of securities stored in its basement vaults, is another case in point. These are heavy prices to be paying, both in human toll and property loss, to save a few dollars in the original cost of the buildings.

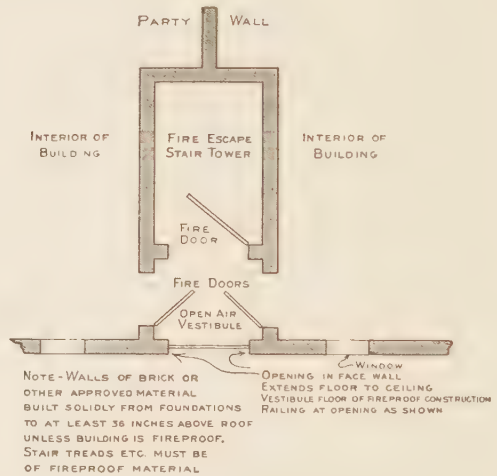


TOWER PLAN WITH OUTSIDE BALCONY ENTRANCE

The best type of stair tower, both from a life and fire standpoint, is that which is required in the city of Philadelphia for a fire escape. It consists of a substantial shaft without communication to the building, access to it being by means of outside open balconies. In this type of tower there is no chance for fire to spread from one floor to another by means of the stairway and the likelihood of its becoming full of smoke is remote. The next best type is a brick or reinforced-concrete enclosure with automatic or self-closing fire doors on the necessary openings to the various floors. While tile or wire-lath and plaster on metal studs constitute passable enclosures, they are easily broken by accidental knocks and are not to be recommended.

Elevator enclosures should receive the same treatment as stairways. In many mills the elevator openings are protected by trap doors, either held open by fusible links similar to

those used in connection with fire doors, or else normally always closed, being operated by the elevator as it passes up and down. Both types are a make-shift and should not be employed except possibly in the improvement of existing buildings when it is impossible to build the shaft. Automatic trap doors should never be used on stairways when the safety of life depends upon the use of the stairway.



STAIR TOWER WITH OUTSIDE ENTRANCE COMMON TO TWO NEIGHBORING BUILDINGS

Beltways should be in fireproof towers with the necessary openings for access and the line shafts made as small as possible and protected by fire doors. All chutes and other floor openings necessary for carrying on the processes should be properly protected, using automatically closing doors, dampers, etc. It must be remembered that a chain is only as strong as its weakest link. Correlatively, a building is capable of confining a fire to a single floor only in proportion to the efficiency of the weakest protection on the floor openings. It is manifestly a waste of money to build adequate stair and elevator enclosures and then pierce the floors with unprotected belt, chute and other openings. Yet it is frequently done.

THE POWER SITUATION IN THE STATE OF NEW YORK

By A. H. Perkins

The State of New York has been rather slow in realizing the vast amount of power available by means of its great network of natural streams and reservoirs. Mr. Perkins discusses the cause of such apparent oversight; outlines the present plans of the Conservation Commission, and deals at length with the water-power demands and water-power supplies of the State.—THE EDITORS.

WHEN, in 1907, the State of New York first began the work of systematic power investigation on a large scale, she but took part in a movement world-wide in extent. The conservation movement as applied to water powers was in various stages of development in widely scattered States and countries. Switzerland was then voting upon the proposition of State monopoly of water power; Sweden was beginning her policy of governmental development and ownership; France and Italy were active in promotion and control; the Province of Ontario, Canada, had completed its public education, legislation had been passed, and active construction was about to begin; the water powers of California were being swiftly syndicated; Wisconsin had passed a general act in relation to water storage; the United States government had begun to have a policy; in fact, wherever nature had furnished the natural resource, the struggle for its possession for utilization or speculation was in active progress.

This world-wide activity in this line was due to the extension of the limits of economic power-transmission made possible by the perfecting of high-tension apparatus. Powers previously too remote from labor and transportation facilities to be utilized were made valuable, and public and private enterprise alike took cogni-

zance of the new opportunities, and were ready to capitalize further possibilities.

During the past five years the various plans noted as proceeding in 1907 in so many different places, were consummated. Switzerland and Sweden have found governmental ownership at least sufficiently successful to require expansion; Ontario is serving its citizens with cheap power with distinguished success and increasing popularity, and is thus bidding high for rapid industrial expansion, and getting it; private enterprise has continued and consolidated its monopoly of water powers in California, and there undeveloped powers are being held in "cold storage" while the power from developed sites is sold at a price just below the cost of power that can be produced by steam from coal at \$10 per ton, Wisconsin has passed and had declared unconstitutional a further law attempting virtually to vest in the State, ownership in both the developed and undeveloped water powers, and so on.

In the meantime, New York through various agencies, now chiefly represented by the Conservation Commission, has been giving much money and study to the subject of water-power development and conservation. There has been gathered and classified a large amount of invaluable scientific data as to rainfall, stream flow,

location and amounts of developed and undeveloped powers, location and capacity of and benefits to be derived from proposed reservoirs for storing and conserving flood waters, preliminary surveys and designs for the structures required for water storage and power development, and the legal and economic questions involved in the development of these natural resources.

The legal problems have been difficult, and as a result New York has not yet progressed beyond the investigating stage. Although large quantities of power are still running to waste, it may be well that it is so. We are advancing far each year in our knowledge of the subject, and our views are changing rapidly. The ultimate proper solution of the power problem may have been made possible by the difficulties preventing an earlier solution.

The present total capacity of primary power plants of all sorts installed in the State of New York is approximately 4,000,000 horse power. The curves shown in Figure 1, derived from census reports, show the present status and past development of the various classes of power going to make up the total. At the present rate of growth the power requirements of the State will be 5,000,000 horse power of installed power in 1915, and 7,200,000 horse power in 1920. Such a growth may or may not occur. The pulp industry which now uses about 400,000 horse power of water power in the State, is subject to an economic tendency to seek power sites remote from centers of population. This tendency results from the use of large amounts of power relative to labor employed. The future principal expansion of the pulp industry will, therefore, occur at points where power will be cheaper than it is likely to be in New York

State. The same is probably true of some electro-chemical processes. On the other hand, the expansion of electric railways will probably continue, though possibly at a less accelerated rate.

The steady increase not only in the total power required in the United States, but also in the power used per wage earner, is a notable feature. From two to nearly six times as much power is required per wage earner as was the case in 1870. The total power used in manufacture has increased about sixfold in the same period. If the highest rate of increase of the ratio between number of horse power and number of wage earners had applied to all industries, it would have meant that the manufacturing industries would have furnished no additional employment to labor, the necessary increased production of manufactured articles being furnished in that case by mechanical rather than manual means.

The table indicates the industries that furnish most employment to labor in the utilization of power. These are in general the textile manufactories. With them, in the total cost of production, power is tertiary in importance, and labor and transportation all important. Such industries seek locations adjacent to labor markets and transportation facilities, and if these industries are to be stimulated by cheap power it must be delivered to the labor market and to the site of good transportation facilities. Power cannot be an inducement to manufacturers to locate their extensions or new plants in this State under any other conditions.

The statistics to make a table like Table I, but applicable to New York alone, are not available to the writer. As such a large portion of the power used in the State is employed in the pulp and paper industries, it is prob-

TABLE I.—POWER IN SELECTED INDUSTRIES, WITH PERCENT OF INCREASE; HORSE-POWER PER WAGE EARNER; AND HORSE POWER PER \$1,000 OF PRODUCTS, 1870 TO 1905

Industry	Census	Horse Power	Percent of increase in H. P.	Average number of wage earners	H. P. per wage earner	Value of products	H. P. per \$1,000 of products
Agricultural Implements....	1905	106,623	38.1	47,394	2.2	\$112,007,344	1.0
	1900	77,189	53.2	46,582	1.7	101,207,428	0.8
	1890	50,395	12.7	38,827	1.3	81,271,651	0.6
	1880	44,731	71.5	39,580	1.1	68,640,486	0.7
	1870	26,082	....	25,249	1.0	52,066,875	0.5
Boots and Shoes.....	1905	62,587	23.6	149,924	0.4	320,107,458	2.0
	1900	50,623	65.0	141,830	0.4	258,969,580	0.2
	1890	30,686	165.1	133,690	0.2	220,649,358	0.1
	1880	11,574	278.9	111,152	0.1	166,050,354	0.1
	1870	3,055	....	91,702	^a	146,704,055	^a
Cotton Goods ^b	1905	1,039,648	28.1	315,874	3.3	450,467,704	2.3
	1900	811,347	74.5	302,861	2.7	339,200,320	2.4
	1890	464,881	68.7	218,876	2.1	267,981,724	1.7
	1880	275,504	88.6	185,472	1.5	210,950,383	1.3
	1870	146,040	....	135,519	1.1	177,489,739	0.8
Flour and Grist Mill Product	1905	^c 780,042	16.1	39,110	19.9	713,033,395	1.1
	1900	672,084	^d 10.7	32,226	20.9	501,396,304	1.3
	1890	752,365	^d 2.4	47,403	15.9	513,971,474	1.5
	1880	771,201	33.7	58,407	13.2	505,185,712	1.5
	1870	576,686	....	58,448	9.9	444,985,143	1.3
Hosiery and Knit Goods....	1905	83,814	44.3	103,715	0.8	136,558,139	0.6
	1900	58,087	68.2	83,387	0.7	95,482,566	0.6
	1890	34,538	198.8	59,588	0.6	67,241,013	0.5
	1880	11,561	77.9	28,885	0.4	29,167,227	0.4
	1870	6,498	....	14,788	0.4	18,411,564	0.4
Iron and Steel (blast furnaces, and steel works and rolling mills).....	1905	2,722,508	63.0	242,640	11.2	905,787,733	3.0
	1900	1,670,547	124.0	222,490	7.5	803,968,273	2.1
	1890	745,824	87.7	148,715	5.0	478,687,519	1.6
	1880	397,247	132.8	140,978	2.8	296,557,685	1.3
	1870	170,675	....	77,555	2.2	307,208,696	0.6
Lumber and Timber Products	1905	^e 1,504,693	8.8	404,626	3.7	580,022,690	2.6
	1900	1,383,002	43.9	413,335	3.3	555,197,271	2.5
	1890	961,316	17.0	311,964	3.1	437,957,382	2.2
	1880	821,928	28.1	147,956	5.6	233,268,729	3.5
	1870	641,665	....	149,997	4.3	210,159,327	3.1
Paper and Wood Pulp.....	1905	1,122,564	46.8	65,964	17.0	188,715,189	5.9
	1900	764,847	156.9	49,646	15.4	127,326,162	6.0
	1890	297,724	140.3	31,050	9.6	78,937,184	3.8
	1880	^e 123,912	128.3	25,631	4.8	55,109,914	2.2
	1870	54,287	....	18,021	3.0	50,842,445	1.1
Silk and Silk Goods.....	1905	78,888	28.5	79,601	1.0	133,288,072	0.6
	1900	61,395	107.1	65,416	0.9	107,256,258	0.6
	1890	29,638	236.4	49,382	0.6	87,298,454	0.3
	1880	8,810	361.0	31,337	0.3	41,033,045	0.2
	1870	1,911	....	6,699	0.3	12,210,662	0.2
Woolen Goods.....	1905	163,793	17.3	72,747	2.3	142,196,658	1.2
	1900	139,645	14.0	68,893	2.0	118,430,158	1.2
	1890	122,501	15.0	76,915	1.6	133,577,977	0.9
	1880	106,507	25.2	86,504	1.2	160,606,721	0.7
	1870	85,101	....	77,870	1.1	155,405,358	0.5
Worsted Goods.....	1905	130,620	34.1	69,251	1.9	165,745,052	0.8
	1900	97,383	70.5	57,008	1.7	120,314,344	0.8
	1890	57,111	247.5	42,978	1.3	79,194,652	0.7
	1880	16,437	105.1	18,803	0.9	33,549,942	0.5
	1870	8,016	....	12,920	0.6	22,090,331	0.4

^a Less than one-tenth of 1 horsepower. ^b Includes cotton small wares.^c Exclusive of custom mills. ^d Decrease.^e Horse power exclusive of "wood pulp," for which figures were not accessible.

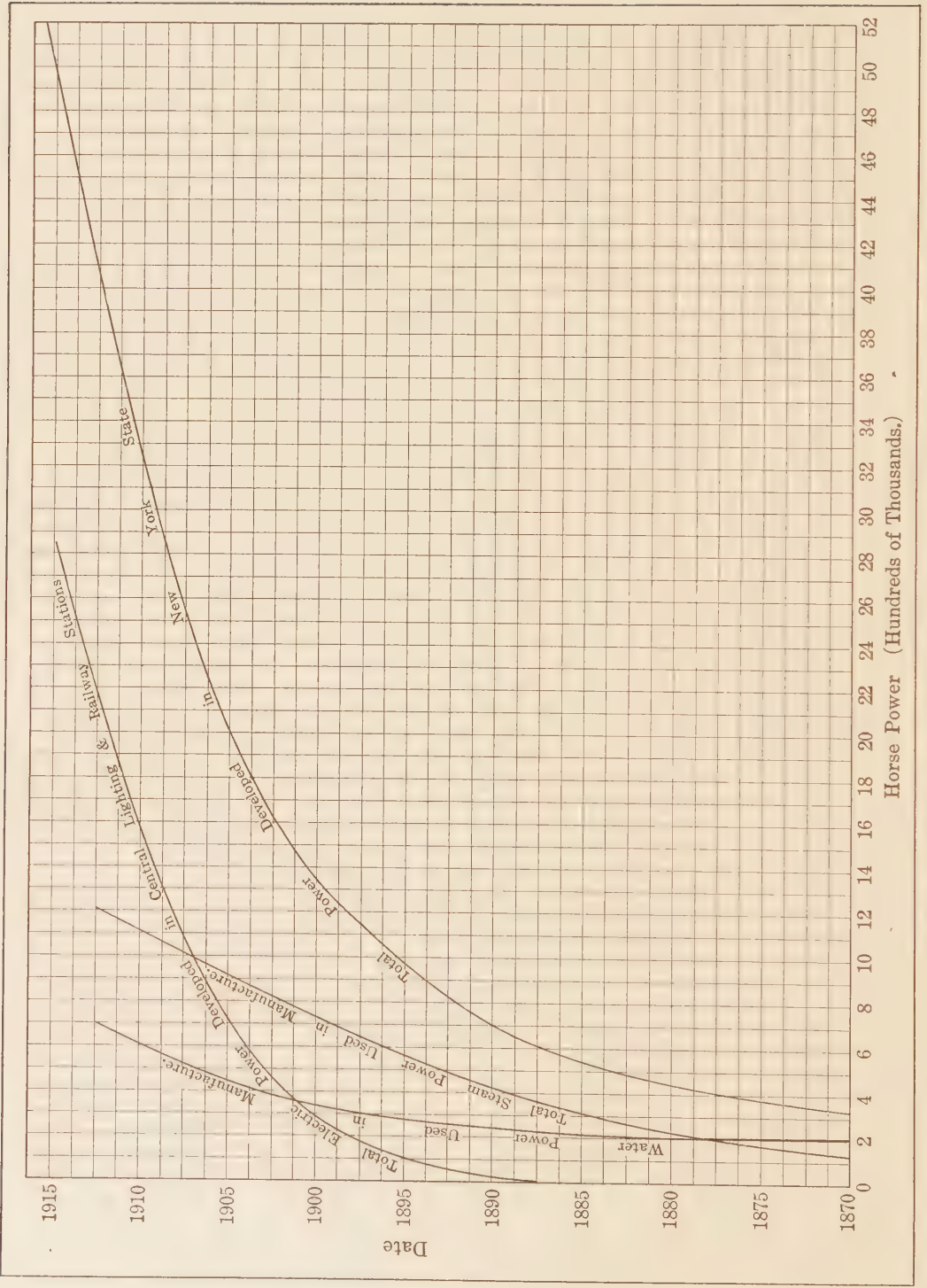


FIG. 1. INSTALLED POWER IN NEW YORK STATE, FROM UNITED STATES CENSUS REPORTS
Quantities here given do not include power used on steam railways, private electric plants, and non-manufacturing uses.

able that in New York the average number of horse power used per employee is higher than for the whole United States. This is further indicated by other census reports. They show that while New York State leads the other States in population, she stands fifteenth in the list of States arranged according to percentage of population gainfully employed, and in the list of States arranged in the order of percentage of population engaged in manufacture she is ninth. How the 800,000 horse power of developed water power in the State is used is shown in Table II.

TABLE II.—NATURE OF MANUFACTURES

	No. of Horse Power used per Employee
Tools and implements.....	.678
Cotton and woolen goods.....	.759
Miscellaneous manufacturing...	2.35
Paper manufacturing	13.33
Flour and feed.....	15.93
Lumber and wood working....	6.76
Pulp grinding and excelsior....	23.00
Electricity	74.00 ¹
All industries exclusive of electricity	4.08

¹ This figure is misleading because it takes no account of the employes at the places where the electricity is used for power production.

The data are insufficient to give the geographical distribution of the power requirements of the State. There are, however, several well marked centers and lines. The group of cities in the vicinity of the eastern end of Lake Erie is a heavy power consumer. Large amounts of power are consumed in the string of cities along the Erie Canal, the foot of the Finger Lakes, and along the Oswego River. St. Lawrence and Jefferson counties are large power producers and consumers. The Albany group, located near the eastern end of the Erie Canal, together with the cities to the north, use large quantities of power, and are already largely sup-

plied with hydroelectric power. The cities of the southern tier use considerable power, but are not grouped together as advantageously as in the other cases mentioned. All of these groups and lines, except the New York City group, are located within easy transmission distance of water powers ample for all present needs, and even in the case of the New York City group, power can be produced and transmitted from the Upper Hudson group of powers at a price somewhat below that of power produced by steam in the largest plants.

In order to compute the power necessary to operate the entire industrial machinery of the State from a general system of power distribution, we must know how to interpret properly the figures already given. We have previously estimated the total installed power in the State at about 4,000,000 horse power. Of this about 800,000 horse power is now operated by water power, leaving 3,200,000 horse power of installed capacity principally supplied by steam engines. Further reductions must be made for those plants in which some waste product is used for fuel, and for those plants where large amounts of steam are used somewhere in the process. In these cases power is obtained as a by-product at small cost. Probably the total installed capacity of steam engines and other prime movers that could be profitably replaced by hydroelectric power does not exceed 2,500,000 horse power.

Note that this is *installed* capacity. Each manufacturer or other user requires at times power greatly in excess of his average needs. In power-distribution work it has been found that the capacity of installation at the central station need be only one-half to one-sixth the sum of the capacities of motors attached. One-third is a very usual figure in central-

station practice. What would be the relation between necessary capacity of plants supplying the entire State and the total installed capacity of engines now supplying those needs cannot be surely stated. Probably we shall be over-estimating the requirements if we take the amount of installation of water power plants at one-half the aggregate of the present steam plants, giving 1,250,000 horse power as the amount of new water power that must be installed in order that the entire industrial machinery of the State may be, as far as practicable, run with water power.

Having discussed the water-power demands of the State, we will consider the water-power supplies. In determining the aggregate supply for comparison with the 1,250,000 horse power aggregate demand, we must be sure that the supply can be furnished in the same way that the demand occurs. Mills and factories run principally in the day time. The power for lighting must be supplied at night and principally in the early part of the night. Similarly, electric railways require more power in the morning when people are going to work and in the evening when they are returning. It has been found in practice that the average load on a central plant will be from one-third to two-thirds of the maximum load. If we take the average load on our system at one-half the maximum, or "peak," we shall be on the safe side in computing the power capacities of our water powers for comparison with the maximum demand. If there is above the dam no pond of sufficient size to store the night flow for day use, then when the factories and other day power consumers shut off their power the water must waste over the dam. In this case, the maximum load that the plant can carry will be no greater than the low-water

flow of the stream. On the other hand, if there is pondage at the power dam, the night flow may be conserved for use during the day, and the plant installation for carrying the peak load may be double the capacity of the stream. Again, the stream flow varies in different portions of the year. By building large reservoirs at suitable places on the stream, the power economically obtainable from the stream may be increased in some cases more than 50 per cent, and the low-water power several hundred per cent. The seasonal variation of stream flow and the demand variation may also be taken care of by steam plants operating only during the portion of the time when the stream flow is insufficient. As examples of these various conditions, we may mention the Niagara River, where the International Treaty allows 20,000 cubic feet per second to be extracted on the American side from the flow of the river. The power that this amount of water will afford is then the limit of the aggregate capacity of hydraulic plants that can be installed. When the demands on the plants do not require 20,000 cubic feet per second, the water not used goes down the stream. There is no pondage nor storage possible under the system imposed by the treaty. At the other end of the scale is the Sacandaga project, where practically the entire flow of the Sacandaga River can be conserved and used as demanded throughout the year.

In the estimates of available undeveloped power given below, all these factors have been considered and the figures given are such as can be compared directly with the 1,250,000 horse power of demand. To carry peak loads of the magnitudes given in the table of supply, auxiliary steam power aggregating, as a rough estimate, about 750,000 to 1,000,000

horse power would have to be installed, but it would have to be operated at full capacity but about one-sixth of the time or its equivalent, and would not have to be installed until the demand for power exceeds the power that can be supplied from low-water stream flows. For instance, at Niagara the power now unutilized at the Falls and in the rapids below is 380,000 horse power continuously. To adapt this to the varying demand with its daily peak load, 380,000 horse power of steam auxiliary might be installed, giving a peak capacity of undeveloped power of 760,000 horse power. The energy required from such an auxiliary plant would be about the equivalent of operating at full capacity four hours per day. Such a steam plant would not be installed, however, until the peak load demand exceeded 380,000 horse power.

In addition to the powers here listed, there are a large number of small undeveloped powers in the State either too small or too remote from transmission lines to be considered in this connection.

EXPLANATION OF ITEMS OF POWER SUPPLY

Niagara River.—By treaty between the United States and Great Britain the water which may be extracted

from the Niagara River for power purposes on the United States side is fixed at not exceeding 20,000 cubic feet per second. By law, the Secretary of War may issue permits for the use of this water. There is now installed machinery for developing about 160,000 horse power. A large proportion of the total fall between Lakes Erie and Ontario is unutilized; and one of the plants wastes in friction a large part of the head existing between its head-works and tail water. Utilizing the available head (300 feet) between the head race of the Niagara Falls Power Company and the Devil's Hole, the 20,000 cubic feet of water per second would give 540,000 horse power. Deducting the 160,000 now developed, leaves 380,000 horse power as about the ultimate of the undeveloped horse power on the American side under the existing treaty. When the time arrives that more power is needed, much more can be developed on the Niagara without impairing scenic effects. One method would be to cause a more equal distribution of the flow along the crest of the fall. The great mass of water now flows over the Horse-shoe. The concentration causes unnecessarily rapid recession of the fall and the extraction of half the water from this portion to be distributed

TABLE III.—TABLE OF PEAK LOAD CAPACITIES OF UNDEVELOPED WATER POWERS
SUPPLEMENTED WITH STEAM POWER
(See Explanation of Items in the Text)

	Capacity of Hydro-Electric Installation	Capacity of Auxiliary In- stallation (Approx.)	Peak Load Capacity
Niagara River	380,000	380,000	760,000
St. Lawrence	461,000	200,000	500,000
Canal System	105,000	25,000	105,000
Genesee River	115,000	15,000	125,000
Salmon River	35,000	5,000	40,000
Black River	30,000	15,000	30,000
Raquette River	150,000	80,000	170,000
Oswegatchie River	20,000	10,000	20,000
Hudson River System.....	373,000	79,000	403,000
Total.....	1,669,000	809,000	2,153,000

over the rest of the crest would permit of much greater power development together with the enhancement of scenic effects. Another method would consist in the storage of the water flowing over the fall at night in order that it might be used for scenic effect during the day and power as required. These methods are not required at present, but will be applicable when the expansion of industries creates the demand for the power. The ultimate peak load capacity that may be realized, without interference with scenic effects, by these methods, when supplemented by steam auxiliary for peak loads, is probably over a million horse power.

St. Lawrence River.—The principal development practicable on the St. Lawrence is at the Long Sault. About 600,000 horse power will be available from the minimum flow of the river, and 925,000 horse power can be economically developed, using steam auxiliary during the low water periods. Although 95 per cent of the water of the St. Lawrence flows on the south side of the boundary line at the Long Sault, thus furnishing a basis upon which the United States could claim 95 per cent of the power, the treaty governing boundary waters adopts the principle of "equal and similar rights in the use of the waters hereinbefore defined as boundary waters." Hence, but half of the power is credited to New York State.

Genesee River.—The power given is figured for stream flow regulated by a storage reservoir at Portage. This reservoir will give a flow at Portage from which an average power of 36,000 horse power will be available in a plant attached to the dam by tunnel. The reservoir has a storage capacity of 13.4 billion cubic feet available for power, and this enormous pondage makes practicable the installation of a plant of sufficient

capacity to carry nearly the whole peak load. Fluctuations in stream flow occurring over a period of years make a small stream auxiliary advantageous. The hydraulic equipment is planned at the reservoir to have a working capacity of 70,000 horse power with 10,000 horse power of spare machinery. The remainder of the power of the river occurs below the reservoir plant.

Salmon River.—A plant is now being designed by a private corporation for this development and it is understood the reservoir lands have been purchased.

Raquette River.—The estimate of the amount of power is based upon a flow regulated by a storage of 11.4 billion cubic feet capacity to be located above Tupper Lake Village.

Hudson River.—The Hudson River figures are based upon stream flows to be regulated by four storage reservoirs having a combined effective capacity of 46 billion cubic feet. The principal one of these is the Sacandaga already mentioned, having an effective capacity of 28.8 billion cubic feet. From the reservoir dam it is planned that a tunnel 21,000 feet long shall extend down to a power house with an ultimate installation of about 90,000 horse power total hydraulic capacity, with 80,000 horse power maximum output. In connection with this ultimate development there will be required a steam auxiliary of 10,000 horse power capacity. The water available in an average year would operate 40,000 turbine horse power continuously 24 hours per day 365 days per year after allowing 80 per cent efficiency of turbines. This statement will give an idea of the method used in determining the values given in the table. The hydraulic installations at all plants not attached to a storage reservoir or so close to it as to be operated practically as a part of

the attached plant, have been taken at such a size as can be operated at full capacity about 60 per cent of the time, and deficiencies provided for by steam auxiliary. This will be recognized as a conservative installation. Pondage where known to exist has been considered as reducing auxiliary required.

Comparing the demand with the supply it will be seen that the water powers of the State are sufficient to operate all the industrial machinery of the State, except steam railways, and allowing the present rate of growth, complete utilization could not be effected until about 1920. As a practical matter complete utilization could not take place anywhere nearly so soon even if construction could be completed. The principal utilization will doubtless come through industrial expansion rather than industrial revolution.

The economic and legal problems arising in connection with a proposed development of this magnitude are very difficult. A definite State policy seems to be clearly crystallizing. The title of the act of 1907 contained the following words, "To devise plans for the progressive development of the water powers of the State for the public use under State ownership and control." The platforms of both political parties contained similar declarations in the 1910 elections. Governor Dix reiterated the policy in his first annual message and has consistently advocated and worked for the policy. The Conservation Commis-

sion prepared a bill providing for the development and distribution of hydroelectric power throughout the State in substantially the same way as Ontario is doing. Under this plan the power was to be sold to municipalities at its cost to the State after paying all operating costs, interest and sinking-fund charges, etc. The municipalities were to use the power for public uses, and to sell to private consumers practically without profit.

This bill received the support of the Governor and passed the Senate, but was not reported in the Assembly.

The utilization of the undeveloped water powers for inducing industrial expansion seems economically sound. Private enterprise cannot be expected to do anything that it believes would at least temporarily depreciate the market value of investments in power enterprises, and even if it would, the legal and political difficulties are very great—so great, in fact, as to be deemed insurmountable to anything but the sovereign power. Over three-fourths of the water supply is either owned *in toto* by the State as riparian owner, or the State has a claim upon it that will require adjudication with good chances of success to the State. State ownership and operation seems the only logical policy under these conditions, however much some of us are inclined to deprecate such a course. The object to be obtained is so vital to our general industrial welfare that it seems essential that the work be undertaken by some agency adequate to the purpose.



EDITORIAL COMMENT

THE MAKING OF GREAT ENGINEERS
ENGINEERING education, after nearly half a century of steady development and expansion along fairly regular lines, seems to be passing through a critical stage of change to a different formula of progress. Harvard has already placed her engineering schools on a graduate basis. Columbia is just admitting the last class that will be received for the old four-year course. A more significant step yet is being taken at the University of Illinois. Dean Goss styles it "the beginning of the next great step in engineering education." "Its way of approach," he says, "is through the administration of its graduate school, whose activities follow those of a regular four-years' course in engineering and are so highly scientific in character as to require the work of the preceding four years as a preparation." The engineering graduate with his degree of bachelor of science may obtain a master's degree by one year of graduate work and a doctor's degree by two years additional after the master's degree.

The project is inspired by the belief that unprecedented requirements in the utilization of resources, the development and application of power, the design and erection of structures, demand engineers of exceptional vision and power—men "who can bring broad and inspiring conceptions to their work." "There are never enough men who can cope with the exceptional tasks."

The question that suggests itself, of course, is whether exceptional vision, exceptional conception, exceptional power of execution, can be first attracted and then trained and developed better by seven years of

college study than by four years—whether the courses will enlist and hold the type of "men who can successfully cope with exceptional tasks," or whether other considerations will determine the membership and complexion of the body of students enrolled. That the world has not usually obtained its exceptional men through such processes in the past is perhaps no argument against the undertaking. We do not know what Brunel, or Watt, or Bessemer, or Edison might have done if he had followed such a course of education. It would be most interesting to come back in fifty years and study the result.

SMOKE ABATEMENT

LAST autumn we mentioned in these columns the promising undertaking of a thorough investigation of the smoke nuisance by the Department of Industrial Research of the University of Pittsburg. Rapid progress seems to have been made in the organization and prosecution of the work. An announcement just issued shows that the present staff assembles twenty-five specialists, of whom seven are giving their entire attention to this particular task.

As an effort of this character must proceed to success by securing the support of public opinion through public education, the Department has arranged a course of lectures to be delivered by members of its staff, presenting the principal phases of the subject in a manner suited to awaken and increase general interest and to meet the inquiries coming from many cities where like problems are encountered. The subjects are: (1) The Smoke Nuisance; (2)

Smoke and Public Health; (3) Smoke and the Cost of Living; (4) Smoke and Plant Life; (5) Methods and Means of Smoke Abatement; (6) The Effect of Smoke on Buildings and Building Materials; (7) The Psychology of Smoke; (8) The Smoke Nuisance and the Housekeeper. It is announced that these lectures will be delivered anywhere east of the Mississippi, the expenses of the lecturer are defrayed.

INDUSTRIAL ALERTNESS

INTERESTING side-lights on the relative weight of interest taken in various topics closely associated with the engineering industries, are reflected in the report lately issued by the Board of Directors of the Y. M. C. A. of Worcester, Mass.

Worcester is a typical New England manufacturing town. While its underlying tendencies may be influenced by the conservatism which is supposed to belong to the New England civilization, its diversity of population and of occupations brings it face to face with all the characteristic problems and difficulties of modern works management.

The Educational Department of the Y. M. C. A., directing its effort toward subjects which appeared to be of most current importance, conducted during the winter of 1911-'12 twenty lecture courses, the subjects being Agriculture, Aeroplane Models, Automobile School, Choir, Civil Service, Debating, Electricity, English for Foreigners, First Aid, Free-hand Drawing, Mechanical Drawing, Plan Reading, Orchestra, Reading, Writing, and Arithmetic, Salesmanship, Scientific Management, Steam Engineering, Wireless Telegraphy, Wood-working.

Scientific Management as used here meant broadly the newer ideas of industrial operation, including all

the philosophies of organization, management, and wage systems, the theory and practice of cost determination—in fact, the application of principles of efficiency throughout the producing, selling, and commercial departments. The significant point mentioned above is the grasp which this Scientific Management course evidently took and held upon the attention of a representative industrial community. Out of a total enrolment of 768 in all the courses, 250 attended the course in Scientific Management. In popularity as shown by enrolment, the numerical order of the first seven courses was as follows: Scientific Management, 250; English for Foreigners, 156; Electricity, 54; Agriculture, 33; Automobile School, 29; Orchestra, 27; Civil Service, 18.

But this is not all. Most striking is the sustained interest shown by the percentage of actual attendance maintained throughout the course. The order of precedence on this basis is as follows: Scientific Management, 96 per cent; Agriculture, 72 per cent; Orchestra, 71 per cent; Salesmanship, 70 per cent; Steam Engineering and Civil Service each 57 per cent; Wireless Telegraphy, 56 per cent. English for Foreigners, which stood second in numerical strength, showed an actual attendance ratio of only 3 per cent.

General observation indicates that the same activity of interest was exhibited in these same lectures as delivered in other New England cities—notably Providence and Springfield; but the careful tabulation of the Worcester data affords the best opportunity for comparative study. Evidently, the prosecution of industrial efficiency is a very live subject among the owners, managers, and officers of New England manufacturing plants.

REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA

LIMITING DIMENSIONS OF SEA-GOING VESSELS

CONCLUSIONS ON THE SUBJECT PRESENTED TO THE TWELFTH
INTERNATIONAL CONGRESS OF NAVIGATION

C. E. Grunsky—International Marine Engineering

FOR discussion at the Twelfth International Congress of Navigation three subjects were chosen for each of the two sections. Individual papers on these subjects were prepared by experts from nearly every maritime country in the world. Prior to the publication of these papers they were submitted to a reviewer or general reporter appointed for each question, whose duty it was to present an analysis of all the papers transmitted to him, giving his own views regarding the subject and drawing up a conclusion to be voted on at the Congress. In the following is presented an abstract of the summary formulated by Mr. C. E. Grunsky, general reporter on the question: Dimensions of Maritime Canals—Probable Future Dimensions of Sea-Going Vessels.

This question is understood by the general reporter to relate specifically to the minimum dimensions of the canals and to the dimensions of the large seagoing vessels. The interrelation of the size of the largest seagoing vessels and of the required dimensions of the canals to carry the largest vessel, is recognized in the question.

If it be admitted that the dimensions of the seagoing vessels are to

be determined solely by the needs of trade and commerce, by economy of operation, and by the demands of passengers for speed, comfort and luxuries, without regard to harbor facilities and without regard to the possible usefulness of the vessels to their governments in case of war, then it becomes comparatively easy to predict future growth. As might be contended, the law would really be inexorable, and no one could foresee a limit to the size of the largest vessel.

But, and perhaps fortunately, there are other considerations to be taken into account, notably the general usefulness of large vessels, which, according to their size and particularly their draft, may be materially restricted by the dimensions of maritime canals and the depth of the approaches to the principal harbors of the world. To this point particular attention is asked, and the Twelfth International Navigation Congress may well consider whether or not it is desirable to point out other means of restricting the rate of increase in the size of vessels than only by the demands of the ship-owners and the ability of the ship-builders to comply therewith.

It appears from all of the papers which have been submitted that

there is no check yet apparent to the rate at which the dimensions of the largest seagoing vessels are increasing. The vessel of over 50,000 tons is being built, and those who should know expect the vessel of 70,000 tons or more to put in her appearance soon.

Would this be possible without government aid? Some of the transatlantic steamship companies are so heavily subsidized that their ships are practically in government ownership. On the Pacific, too, the economic success of transportation in large vessels is made possible by subsidies in one form or another. Our own country, which does not subsidize, is out of the running. It has no merchant marine to speak of. In other words, the operation of large steamers without subsidy is not profitable, at any rate not in competition with the operation of subsidized vessels.

And yet, if commerce between nations had been developed without government aid, and if the commerce on the high seas had been and were carried on only by vessels of moderate size, there would have been a suitable adjustment to such conditions, and there would be little if any less volume of business between nations than is found to-day.

Perhaps, upon careful analysis, it may, even under established conditions, be found preferable to operate ten steamers of 10,000 tons each, rather than only two of 50,000 tons. From the standpoint of the government of any maritime country it would certainly be more desirable to have at its disposal when needed ten ships of 10,000 tons than two of 50,000 tons.

Having given consideration to the views of the experts as presented in these papers, the general reporter adds that no evidence has been found

by him and none is presented in the papers which would indicate that for the present any other consideration than the demands of commerce and the willingness of the traveling public to pay for room, comfort and luxuries, and the ability of the shipbuilders to build the ships will set a limit to the size of the ocean liner. In other words, if the deepening of the harbors and of harbor approaches is continued without restriction the size of the largest ocean liners will, under otherwise permanent conditions, continue to increase.

Without any restrictions upon the size of vessels they will be built constantly larger as demanded by economy of operation and by the needs of commerce, and only those ports can hope to be favored with the visits of the largest vessels which find it worth while to afford suitable harbor facilities.

The growth of vessels, therefore, exerts a strong influence upon the concentration of the export and import business at certain points, such as New York harbor, where nature has made possible the construction of the facilities demanded by the shipowner who wants to operate the largest boats that can with safety and without delay be taken into and out of the best harbors on the two sides of the Atlantic.

It follows from this that it is to the interest of the port which is less favored by natural conditions that some artificial limit be set to the size of the ocean carriers, particularly in the matter of draft, in order that harbor improvements may be planned with reasonable certainty that they will be adequate.

There should be an international agreement entered into that some depth of water at low tide is the standard to which the important harbors of the world should be im-

proved, and there should be no government aid in the form of subsidy or otherwise to vessels whose dimensions are such as to make the entrance into a harbor of standard depth impossible.

It would be unwise, for example, for the United States to construct or to encourage by subvention or otherwise the construction of vessels too large to pass through the locks of the Panama Canal.

The usefulness to the government in time of war of a vessel depends upon its adaptability to the momentary requirements. It should be large enough, and yet not of such colossal dimensions that it cannot make port at some unforeseen new destination.

By the construction of the Panama Canal, a stupendous undertaking, the United States has practically set an upper limit for the dimensions of vessels whose construction can be encouraged by the Government. The canal and the lock system on the canal have cost too much to be readily modified. For the time being the usable lock length on this canal of 1,000 feet, the breadth of 110 feet and the depth of 41.5 feet on the sills of the lock gates, equal to 40 feet in salt water, or to 12.2 meters, has fixed the maximum dimensions both of war vessels and other vessels that are likely to be constructed by the United States or by American owners under the stimulus of Government aid.

But if the standard maximum dimensions for the largest desirable seagoing vessels be thus set by the United States, or by an international agreement participated in by the important maritime nations, this will not set a limit to the further improvement of shipping. There is room for improvement even when the limit of size has been reached.

The internal combustion engine, for example, is full of promise, and may be of material aid in increasing cargo capacity. The gain in cargo capacity resulting in the use of internal combustion engines would, moreover, be of particular value, because it is obtained without an increase in displacement. So, too, in the matter of speed there need be no limit set, unless for subsidized vessels it be a lower limit. If the reduction of weight of machinery and of fuel in the motor boat compared with the steamboat even approaches the figures given in the paper by Mr. Zamjatin, there should be ample opportunity for securing high speed without being compelled to give the vessels abnormal dimensions.

It remains to be stated that the largest vessels on such special routes as the one between New York and European ports stand apart in a class by themselves, and their dimensions need not be taken into account in forecasting the dimensions of the vessels for whose use the great maritime canals such as the Suez Canal and the Panama Canal and other canals of the first rank are constructed.

The following conclusions appear to be justified and are recommended for adoption by the Congress:

I. It is desirable that a limit be set to the draft of sea-going vessels.

2. Government aid should not be extended to the building or operation of sea-going vessels whose draft exceed 32.2 feet.

3. There should be an international agreement fixing the maximum dimensions of sea-going vessels built or operated under Government subvention, and there are tentatively suggested the following: Length over all, 900 feet; breadth, 105 feet; draft, 32.2 feet.

4. Any maritime canal which has

locks with a usable length of 1,000 feet, a width of 110 feet, and a depth of water on the sill of 35 feet will fulfil every reasonable requirement of commerce.

5. In a maritime canal a wet section five times as large as the immersed portion of the largest ship

which is to use the canal is desirable, as also a depth of 1 meter under the keel; but these values are functions of the speed at which the canal is to be navigated, and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

BITUMINOUS ROAD SURFACES

SUPERFICIAL COATS OF BITUMINOUS MATERIAL WITH OR WITHOUT STONE

A. W. Dean—American Society of Civil Engineers

BITUMINOUS pavements of various types have been in use for many years, whereas bituminous surfaces are of recent adoption. The early superficial applications of oil were made largely for the purpose of dust prevention on dirt roads, a crude light oil being used, having very little binding quality. The advent of motor-vehicle traffic, however, has led to a very extensive use of bituminous surfaces, not only for the purpose of dust laying, but for the preservation of the roads. As a natural consequence, many experiments have been tried by road authorities to determine what methods and materials are best adapted to overcome the difficulties encountered, and by producers to determine what quality of bituminous material can be manufactured at a minimum cost to meet the requirements of the road authorities. Being still in the experimental stage, final conclusions regarding methods and materials are obviously impossible. It has been clearly demonstrated, however, that no uniform specification can be adopted defining a material which will produce a good bituminous surface on roads of every type and under every condition of traffic. Experience has shown, for instance, that while a heavy refined tar may

be used to advantage on a macadam road, it is of no value as a surface application on an ordinary gravel or dirt road.

For surface treatment of dirt roads, a light oil helps somewhat to preserve the road, in that it prevents the particles composing the surface from blowing away, and assists, to some slight degree, in hardening the surface.

For surface treatment of gravel roads, the best results appear to be obtained by using an asphaltic oil of what might be termed medium viscosity, or by approximating the maximum viscosity that will permit application through an ordinary distributor at a temperature of 50 degrees Fahrenheit.

For surface treatment of broken stone roads, a light or medium oil acts mainly as a dust layer, yet if frequently applied it preserves the road to a very appreciable extent. In determining what bituminous material would be the most economical and advantageous for the preservation by surface treatment of broken stone roads, a knowledge of the traffic over the road is absolutely essential. If the road is subjected to light motor-vehicle traffic and light team traffic, with the motor vehicles predominating, experience has shown that an

asphaltic oil, of such viscosity that it requires heating to at least 250 degrees Fahrenheit before application, forms a bituminous surface which withstands the traffic and thoroughly preserves the road for a period of time depending partly on the quality of the material and workmanship and partly on the quantity of traffic.

Chemists do not agree unanimously on definite requirements for bituminous materials to be used for surface applications, and, as this method of treatment of roads is of such recent practice, it is probable that at least two years more must elapse before positive specifications can be drawn. Producers claim that the best oils for the purpose contain 90% asphalt. Residuum oils placed on roads in Massachusetts early in the season of 1909, still show life, and an indication of durability for a considerable time to come, and this fact would show that, while natural asphalts may possibly be superior, the residuum asphalts are, nevertheless, suitable for the purpose.

Fully as important as the quality of the bituminous material is the quality of the workmanship in applying it. In the preparation of the broken stone surface, extreme care should be taken to sweep and remove every particle of dust and dirt, so that the stones will be absolutely bare. Many failures of bituminous surfaces can be traced directly to the improper preparation of the broken stone surface, the heavy oils being distributed on dusty and dirty sections, and, consequently, peeling up through lack of adhesion. In order to get the best adhesion of asphaltic oils, it appears that the stone surface should also be somewhat moist rather than extremely dry. In distributing the oil, if the stone surface is comparatively new and smooth, the best results appear to be obtained by applying the

oil under pressure in two applications, each of $\frac{1}{4}$ gallon per square yard, covering the first application with grit or pea stone before putting on the second, and covering the second application with the same material as soon as possible after it has been made. The effect of applying the material in this manner is to make the distribution more uniform and prevent surplus oil from flowing on the sloping crown of the road, thereby causing ridges and bunches to appear after the work has been done. If the stone surface is full of slight depressions, however, a single application of $\frac{1}{2}$ gallon per square yard, applied with or without pressure, has proved satisfactory. The oil tends to run to the depressions, causing a slight surplus of oil in them, so that when the grit is applied on top of the oil, the portions over the depressions absorb more grit, consequently rendering the road smoother.

The character of the grit or other material used for covering the oil is of great importance. Where the traffic is confined exclusively to motor vehicles, sand appears to be as effective as any material for covering, but if there is some steel-tired horse-drawn traffic, a coarse material like pea stone or fine gravel is necessary.

The cost of a bituminous surface as just described will vary, of course, with the availability of the material to be used for covering, and the length of haul of all materials. In Massachusetts, during the last four years, several hundred miles of macadam road have been improved or preserved by a bituminous surface of this kind. The average cost during 1910 was a little less than \$0.08 per square yard, and, during 1911, a little more than that price, with labor costing from \$1.75 to \$2.00 per 8-

hour day, and asphaltic oil costing \$0.06 per gallon delivered in cars.

In maintaining these bituminous surfaces a re-treatment of about $\frac{1}{4}$ gallon of bituminous material per square yard is only made on those places from which the bituminous material has disappeared. The present condition of these roads indicates that the expense for patching and sanding in 1912 will not exceed \$0.01 per square yard, in which case the total expense of maintenance for four years will have been \$0.1076, making the average cost \$0.0269 per square yard, or approximately \$236.72 per mile per year for a 15-foot road. Whether such a surface on a macadam road will withstand the traffic of

heavily loaded motor trucks cannot now be determined, as such trucks have not been in service sufficiently long to permit determinations.

On roads where the prevailing traffic consists of steel-tired horse-drawn vehicles, this application of bituminous surface, consisting of heavy asphaltic oil and grit, has proved unsuccessful, in most instances, the surface being cut and dented to such a degree that it soon disappears. On such a road, it is possible that a heavy, refined tar surface may be economical, or it may be economical to use oil of a lighter grade, applying it with sufficient frequency to keep the surface of the stone covered with oil at all times.

THE SPERRY GYRO-COMPASS

EXPLANATION OF ITS ACTION AND SOME OF THE ADVANTAGES CLAIMED

Engineering

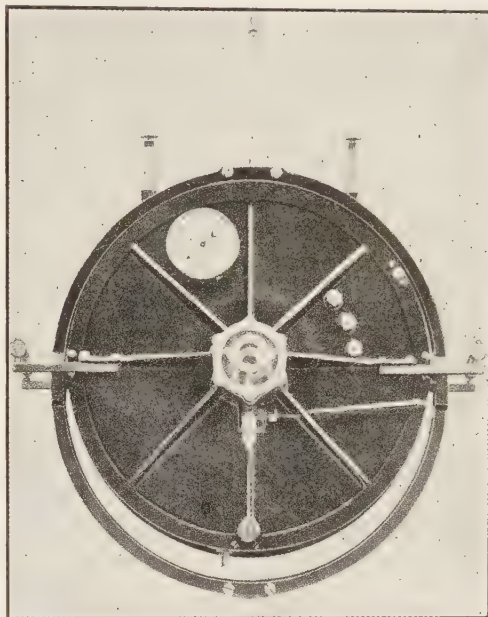
THE Sperry gyro-compass consists essentially of a gyro-scope wheel which is mounted so as to revolve on a horizontal axis, and is carried by bearings on a casing which is itself pivoted on a horizontal axis, but at right angles to the axis of the wheel. The bearings which carry the casing form part of a vertical ring which is suspended at its topmost point by a torsionless strand. The whole of the above parts, which go to make up what may be called the compass element proper, are connected by the torsionless strand mentioned above, and by a restraining spring arrangement, to be mentioned later, to a frame which is mounted to swing in the binnacle by the usual Cardan suspension. The compass-card and the electrical contacts for controlling indicating-cards at a distance are mounted on the frame, which is free

from the compass element. There are electrical connections between the compass element and the frame, arranged so that the frame follows the motions of the compass element. The object and advantage of the arrangement are that the compass element serves only as the directive part of the instrument, but forms no part in actually driving the compass-card on the contacts for distant indicating-cards.

Figure 1 shows a cross-section through the apparatus in the plane of rotation of the gyro-wheel, and illustrates its main parts. The wheel is pivoted on the horizontal axis *a*, which runs in bearings in the casing *b*. Casing *b* is, in turn, carried on the horizontal axis *c*, consisting of pivots fixed in the vertical ring *d*. Ball-bearings are used both at *a* and *c*, and the wheel runs in a vacuum, which is maintained in the casing.

The vertical ring is suspended by the torsionless strand *e*, and is guided by the bearings *f, f*, which allow a free oscillation of limited amount about the vertical axis, inside the outer ring *g*. There is a hollow vertical stem *h* attached to the upper side of this outer ring which forms a bearing for the rotation of the ring in azimuth with respect to the upper frame *j*, and at the same time serves as a point of attachment for the torsionless strand which supports the vertical ring. It will be seen that ball-bearings are used at *f, f*, and also for the vertical stem *h*. The upper frame *j* is mounted to swing in the binnacle through the ring *k*, in the way that is familiar in connection with magnetic compasses.

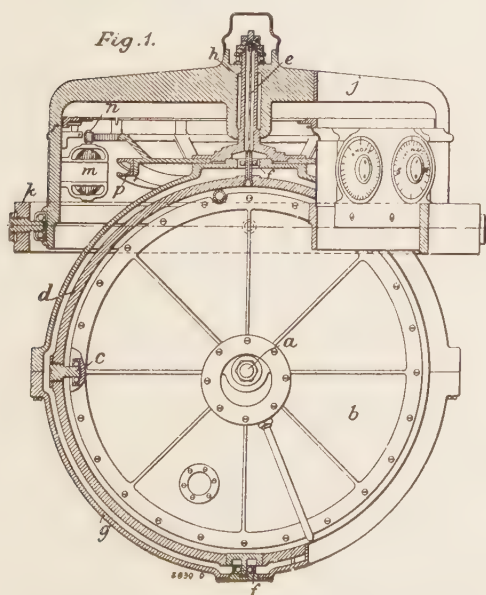
The compass proper serves only as the directive part of the instrument, the driving part being fitted in connection with an independent portion of the apparatus. This is provided for by means of an electrical connection between the vertical ring and the part made up of



COMPASS ELEMENT, FROM NORTH SIDE

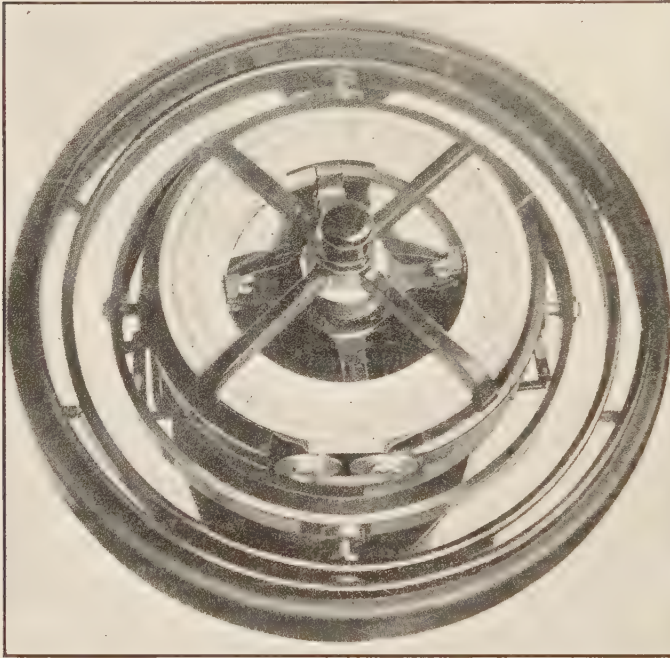
the outer ring and the upper frame. There is a small motor *m* attached to the upper frame and shown in Figure 1, which is controlled by means of electrical trolley contacts fitted to the vertical ring, and which work over fixed contacts secured to the outer ring.

The motor carries a small gearing *n* at its upper side, which drives into a spur-wheel carried by the outer ring, and the electrical arrangements are such that any movement which the vertical ring makes in azimuth immediately starts up the motor which then drives the outer ring until it attains the same position in azimuth with the ring. The result of this is that the compass-card which is carried by *g* is immediately made to indicate any movements which have been made by the ring *d* due to the gyroscopic action of the rotating wheel. This method of securing a power drive independent from the actual directive force of the gyro-wheel is utilized not only to



CROSS-SECTION THROUGH PLANE OF ROTATION

control the compass-card, as explained above, but also to control the electrical arrangements used in connection with indicating compass-cards which are controlled from a distance, and also in connection with an automatic correcting device which is fitted in order to compensate for ships' speed, direction and latitude.



COMPLETE COMPASS, SHOWING BINNACLE SUSPENSION

As the wheel-casing *b* is pivoted on its horizontal axis in the ring *d*, which is free to oscillate about the vertical axis, the gyro-wheel is in indifferent equilibrium, and is possessed of three degrees of freedom. This renders it free from any detrimental effects due to acceleration pressures. Further, since the power-driven ring *g* stands in constant relation to the casing, but independent from it, this ring forms a base from which movements may be made to produce a positive orientation of the gyro-wheel.

Since the wheel is pivoted in equi-

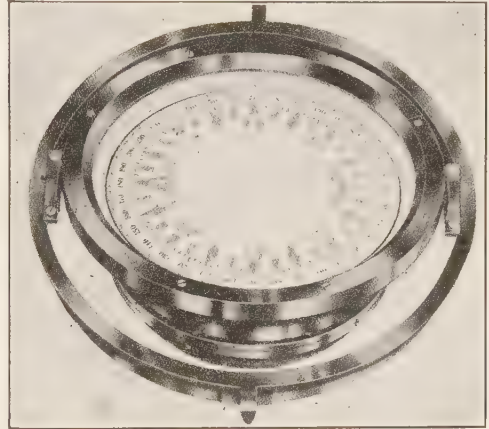
librium on its horizontal axis, it cannot be affected directly by any disturbing influence due to the ballistic effect inherent in a pendulum. This primarily eliminates the principal source of oscillation. An oscillation might, however, be set up in the case of a ship starting with a northerly component of speed. This would result in a westerly deflection, and in attaining this deflection the compass would set up an oscillation and pass far beyond the theoretical limit of such deflection, and then, if left to itself, would vibrate to and fro on each side of the correct deflection. The provision of the connection between the power-driven part of the compass, however, and the gyro-wheel casing restrains its motion, and the wheel will move over to its proper position and stay there. The only other forces which can act on the gyro-

wheel are such as reach it through the yielding connection, and such forces are necessarily applied at a chosen point, which is such that all detrimental effects are automatically neutralised. If, for example, the gyro-wheel be forcibly moved off the meridian and allowed to take its own course, one end of the spinning axis will immediately begin to tilt up, due to gyroscopic reaction, as the earth revolves under it. The moment this occurs the yielding connection between the wheel-casing and the power-driven part of the compass introduces a compound torque factor

tending to return the wheel back to the meridian by the shortest path, and the point of application of this torque is just such as is necessary to give the correct neutralising effect desired.

Figure 1 also shows another feature which has reference to the arrangements made for the automatic correction of the three errors to which a gyro-compass mounted on a ship is liable. These errors are respectively that due to the speed of the ship, that due to the meridional component of the course of the ship, and that due to the latitude. The arrangement consists of two small dials graduated respectively in knots and latitude, which are set at one side. These dials are set by hand

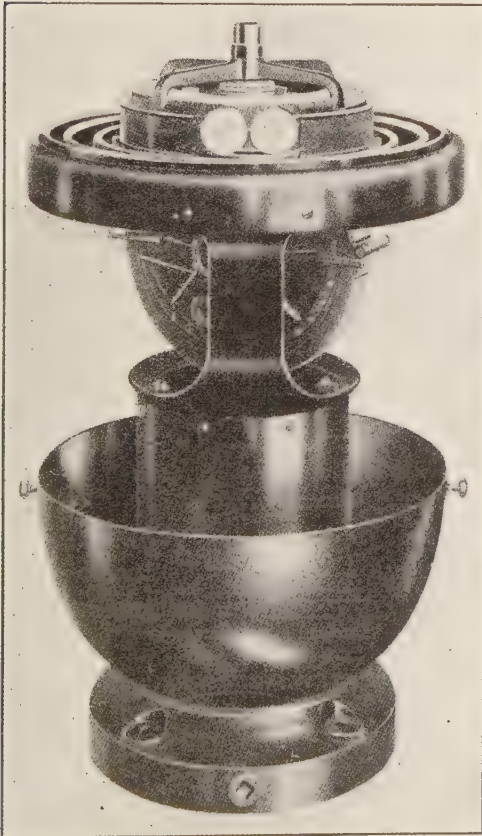
for the conditions under which the compass is operating, and by that setting automatically correct the errors of the gyro-wheel, so that the



BINNACLE TYPE REPEATER COMPASS

compass-card immediately indicates true north.

The compass is constructed to work in conjunction with a series of indicating compass-dials, which may be situated in any part of the ship, and which are controlled electrically from the master gyro-compass. The indicating dials or repeaters are driven each by its own step-by-step motor, which has no moving contact in circuit, and is controlled by a series of current impulses sent out by the transmitters, which form part of the main compass. The repeater compasses follow the movements of the main compass, with a maximum error of about $1/12$ degree, and each consumes about 10 watts as driving power. They have a torque of about 10,000 gm.-cm., which is high enough to prevent any possibility of derangement owing to big-gun fire. The compass has already been installed on several United States warships, and has given results which point to its extensive adoption, not only upon war vessels, but also transatlantic liners.



BINNACLE WITH COVERS OPEN



UNITED STATES BATTLESHIP "FLORIDA"

BRIEF DESCRIPTION AND RESULTS OF OFFICIAL TRIALS

Henderson B. Gregory—American Society of Naval Engineers

THE "Florida" is a four-screw Parsons turbine vessel designed for a speed of 20.75 knots, at 21,825 tons displacement, and with the main engines developing 28,000 shaft horse power. She was built at the Brooklyn Navy Yard, under an Act of Congress approved May 13, 1908, authorizing the construction of two first-class battleships, and which further provided that at least one of the vessels be constructed at a navy yard. The cost, authorized by a subsequent Act of Congress, was \$6,400,000 exclusive of armor and armament. Her sister ship is the "Utah".

There are two masts of the cage or basket type, on which are located searchlight platforms, portions of the wireless telegraphy outfit, signal yards, etc.

There are three bridges: steering

platform, flying bridge and signal bridge, the latter being the lowest. There are no after bridges.

The forecastle deck extends from the stem to frame 51. On its after part is a deck house containing the admiral's and captain's quarters. On its level are skid deck beams, in which are stowed all boats except the life-boats, which hang from davits aft and the two fifty-foot steamers, which stow on the main deck.

The main deck extends from stem to stern. Forward of frame 49 is the wardroom country. Aft of this frame, situated amidships, are deck houses containing the crew's galley, butcher shop, bakery, blacksmith shop and foundry, and two boat cranes. The crane towers also serve as additional searchlight platforms.

The gun deck is also continuous and the full width of the ship. It

has within it, forward of the casemate, the quarters for warrant and junior officers. Within the casemate are located the four firemen's wash rooms, coaling-gear machinery rooms, and general mess store and issuing rooms. Aft and outside the casemate are the offices for the remaining officers, the laundry, sick bay, ordnance storeroom, etc.

The main battery consists of ten 12-inch guns arranged in pairs, in five turrets on the center line of the vessel. Turrets Nos. 1 and 2 are on the forecastle deck, the latter being elevated so as to fire ahead over the top of the former. Turrets Nos. 3, 4 and 5 are located on the main deck abaft of the smoke pipes.

A secondary battery of sixteen 5-inch rapid-fire guns for torpedo defense is also provided, together with the following smaller guns: Four 3-pounder saluting guns; two 1-pounder semi-automatic guns for boats; two 0.30-inch machine guns for boats; two 3-inch field pieces, and also two 21-inch submarine torpedo tubes.

The propelling machinery consists of Parsons turbines, designed to run at 330 revolutions per minute, when developing 28,000 shaft horse power.

Each turbine is composed of two essential parts, first, the fixed part, or cylinder, and second, the moving part, or rotor. In the cylinder are mounted the guide blades and on the rotor the moving blades. The cylinders are of hard, close-grained cast iron, divided into two parts at the axis on a horizontal plane, the lower half being provided with feet for bolting to the seating. Each rotor is built up of a drum of forged steel, securely fastened to a cast-steel wheel at each end, that is shrunk on and keyed to the rotor shaft. Great care was exercised to assure the rotors being perfectly balanced when en-

tirely completed, in order to prevent vibration when running.

The boilers, twelve in number, are of the Babcock and Wilcox water-tube type, arranged in batteries of four each in three separate watertight compartments. They are designed to run the entire machinery installations at full power, with an average air pressure in the ash pits of not more than two inches of water.

The uptakes are of the usual design, and there are two smoke pipes, each about 92 feet in height above the grates and 11 feet 6 inches in diameter.

In addition to the usual coal-burning appliances, a complete oil-burning system is provided. This installation is not intended for regular use, but only as auxiliary fuel to be burned in emergencies in combination with the coal.

The customary engine and fire-room telegraphs, gongs, time-fire device, telephones, voice tubes, etc., are fitted for transmitting orders and signalling to the various machinery compartments and other parts of the vessel.

There is one dynamo room located forward of the forward boiler room, and two distribution rooms, one forward and one aft, in which are located the lighting and power distribution boards for the respective parts of the ship.

The generator installation consists of four 6-pole, compound-wound, 300-kilowatt General Electric generators, each driven by a two-stage horizontal Curtis turbine. Each generator will deliver at normal load 2,400 ampères of current at 125 volts when running at 1,500 revolutions per minute. The generators are capable of delivering one-third overload for two hours without injury.

The "Florida" was placed in com-

mission on September 15, 1911, at the Navy Yard, N. Y., and after a brief sojourn on the Atlantic Coast she sailed south, spending the major part of the winter breaking-in at Guantanamo. Late in February she was ordered north to undergo her official trials.

Four trials were required as follows:

Standardization Trial.—This trial was run on the Rockland, Maine, course Monday, March 25, 1912. In all twenty-two runs were made over the measured mile at various speeds, but the data from only twenty runs was used in compiling the speed and power curves.

From the data obtained it was found to require 321.4 revolutions per minute of the main engines to attain the designed speed of 20.75 knots, 286.3 revolutions per minute, for 19 knots, and 177.2 revolutions per minute for 12 knots.

Four-Hour Full-Speed Trial.—This trial took place at sea off Rockland, Maine, on Tuesday afternoon, March 26, 1912. The weather was clear with gentle breezes and a smooth sea. The designed speed was easily exceeded, an average speed of

22.08 knots being attained, and the designed water rate was likewise bettered.

Twenty-Four Hour 19-Knot Endurance and Coal and Water-Consumption Trial.—The trial commenced at 1:20 A. M., March 27, 1912, and terminated at the same hour on the following day. The weather was clear with light airs and a smooth sea. Unfortunately, unsatisfactory, dummy clearances developed in the starboard L. P. turbine, which rendered it necessary to disconnect the I. P. C. turbine after five hours' running, and to continue the trial with the four-turbine combination, but in spite of this handicap the water consumption was within the designed rate.

Twenty-Four Hour 12-Knot Endurance and Coal and Water-Consumption Trial.—This trial was run on the six-turbine combination, March 28 and 29, 1912, the start being at 4:20 A. M. The weather was excellent throughout the trial, there being no wind and a smooth sea.

The water consumption on this trial was a little in excess of the designed rate, due to the high consumption of the auxiliaries.

RAILLESS ELECTRIC TRACTION

THE COSTS OF SUCH SYSTEMS NOW IN ACTIVE SERVICE IN ENGLAND

R. E. Neale—*Southern Electrician*

THE first trackless trolley systems in England were inaugurated in June, 1911, in the neighboring cities of Leeds and Bradford. Since then, installations have developed so rapidly that there are now thirty localities seriously considering the installation of trolley busses, while systems similar to those in Leeds and Bradford will soon be in operation in the cities of Rotherham and Dundee.

The trolley bus has been aptly described as a cross between a tram car and a petrol bus. It possesses the high starting torque and overload capacity of the former with the low capital cost and flexibility of the latter. The overhead trolley wires are quite unobtrusive, the busses themselves are built on good lines, and their traffic dodging capacities are surprising. Curves at 14 feet radius are easily made, and the sys-

tem as a whole is readily adapted to special circumstances such as are encountered on bridges, level crossings, and so on. If freight busses are run on the same route as passenger cars, it is an easy matter to arrange for the faster vehicles to pass the slower at any time or place. There has been considerable discussion as to the extent of road damage likely to be effected by trolley busses and as to the basis and means of levying indemnity. So far, it appears that the wear and tear on roads is, if anything, less than that produced by petrol, while the saturation of the road surface with grease and oil at regular stopping places is entirely avoided in the electrical system.

The low capital cost of the trolley system enables the profitable operation of routes on which only low traffic density can be secured. The tractive resistance of a trolley bus is of the same order as that of a petrol bus and is much higher than that of tram cars, also, repairs and depreciation are much higher than in the latter, so that, in no case are trolley busses to be regarded as substitutes for tramways, where the latter are laid down on a sound financial basis, but merely as the best available means of securing low operating costs, when the revenue is necessarily low, and of profitably developing the traffic of a district. The most obvious fields of applicability of trolley busses are, therefore: (1) In towns with insufficient traffic to warrant the heavier capital cost of a tramway system and in seaside resorts and other places where erratic seasonal traffic is encountered. (2) As "feeders" to existing tramway and railway routes. (3) In city streets where the rigid route required by tram cars cannot be tolerated. (4) In rural and interurban

schemes in conjunction with the transport of farm produce and the supply of energy for power and lighting to houses and communities en route.

The electrical equipment of the vehicles used at Leeds and Bradford comprises two 20-horsepower, 525-volt, 1,050-revolutions-per-minute, commutating pole traction motors

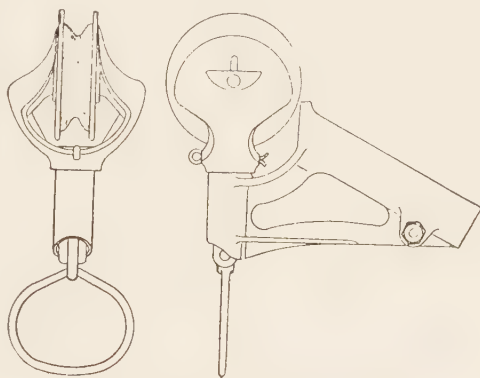


FIG. 1. SWIVEL TROLLEY HEADS

driving the rear wheels through a 10:1 reduction provided by oil-immersed worm gearing and roller chain drive. A series-parallel controller has 9 current positions, 5 running, on the main barrel and 6 on the reversing barrel. Either motor can be cut out at will without removing the controller cover. The speed control provided is much finer and smoother than that on any petrol bus. The trolley boom is of the usual tramway pattern except that in the Leeds vehicles a new type of swivel trolley head, shown in Figure 1, has lately been introduced. The trolley wheel swivel pin runs on ball bearings and, being hollow, carries a tail spindle terminating in a ring as shown. The object of this is to facilitate the placing of the trolley wheels on the overhead wires.

Standard trolley wire is used to supply current, the spacing adopted

in Leeds is 13.5 inches between positive and negative and 9 inches between positive and positive, unless wider pitch is required for the accommodation of frogs and cross-overs.

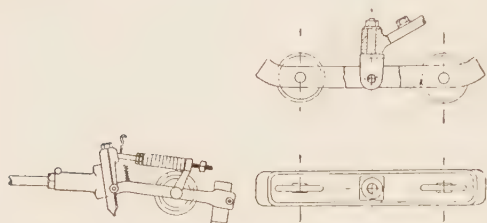


FIG. 2. RAIL SKATES USED ON TROLLEY ROUTES

The Bradford trackless route is about 1.25 miles in length and cross-connects tram routes radiating from the city. It is fed from the tramway feeders at each end and a maximum drop of 4 volts has been observed in each trolley section. The Leeds route is 4 miles in length and the final three miles are fed from the point at which the route leaves the tramway. With two busses running 30-40 volts drop occurs in this 3 miles of trolley route, hence a negative feeder is being run near the far end of the latter from an adjacent tramway. To enable their busses to run over any trolley tram route, the Railless Electric Traction Co. provide pivoted return-current skate booms beneath their vehicles. The rail skate, as seen in Figure 2, consists essentially of a rail scraper and brush, a guide wheel and a 20 pound copper contact block. Its construction has proved satisfactory except that the skate is rather liable to jump the rails and to follow the wrong tracks at points. To overcome these defects, while securing a lighter and cheaper design, the Leeds Corporation adopted bogie-collectors.

As regards smoothness of running, the writer has found trolley busses to compare favorably with the best petrol busses, while the high fre-

quency vibration due to the engine of the latter is, of course, absent. In Leeds, semi-elliptical plate springs carry the bus body, but in Bradford lever spring "shock absorbers" have been adopted. The busses at present in use exceed the statutory weight limits, but in future, no difficulty is anticipated in bringing the weight of the vehicles down to 4.0 or 4.25 tons.

The busses cost \$3,500 apiece and the overall cost of the necessary street equipment averaged \$8,670 per mile in Bradford and \$6,220 per mile in Leeds. The trackless system avoids the heavy track costs of tramway installations but will often be assessed for road improvements which should have been effected long ago. A capital charge of 5 per cent usually averages 0.75 cents per car mile in the railless system. The current consumption of the vehicles ranges from 0.85 to 1.00 kilowatt-hour per car mile; tire maintenance is contracted for at 3.0 cents per mile and the total operating costs, including capital and depreciation charges, vary from 11.0 to 13.0 cents per bus-mile, while the revenue varies from 12.0 to 17.0 cents per mile. The Bradford fare is 2 cents for 1.25 miles but, in Leeds, only 4 cents is charged for a 4-mile journey. In the latter city, the operating costs and revenue are very closely balanced. Whereas 2 cents per passenger mile is required by petrol busses, from 1.0 to 1.5 cents per passenger-mile is profitable to trolley vehicles. There seems no reason to doubt that from 2 to 4 cents per bus mile net profit can generally be realized. This is satisfactory in the classes of service to which trolley busses are best suited. A passenger service is often very desirable though there is no immediate prospect of remunerative traffic unless several towns propose to install a system.

VERTICAL VERSUS INCLINE SHAFTS

CONDITIONS INVOLVED IN THE ADVANTAGEOUS USE OF EITHER

John Malcolm Nicol—Mining and Engineering World

THE purpose for which shafts are sunk in precious metal mining may conveniently be considered under four heads: (1) Those sunk to locate a body of ore in an unexplored vein, that is, prospecting shafts. (2) Those sunk for the express purpose of draining a given zone, either virgin or comprising old workings. (3) Those sunk for the economic development and extraction of a known or assumed body of ore. (4) Those sunk exclusively for ventilation, or for providing additional means of egress from the workings for purposes of safety, etc.

In exploration shafts, when the vein is such that either a vertical or an incline shaft may be sunk, it is generally considered that the incline is preferable, especially in an unexplored district. The advantages in sinking an incline shaft on the vein are the following:

1. That the vein can be followed in all its changes, and no long cross-cuts need be made for extraction purposes.

2. That, if sunk on a rich outcrop, the ore extracted will often pay expenses.

3. That, since the vein is generally of softer material than the surrounding country rock, sinking operations may be conducted more rapidly and economically than either a vertical or an incline shaft in the country rock.

Opposed to these advantages may be considered the items; in porous veins, practically all the water in the region must be drained, while sinking, with sinking pumps; sinking pumps to handle gritty water invariably cause enormous delay in the repair

and replacement of plungers and packing; if the dip varies frequently, great difficulty is experienced in maintaining favorable track and hoisting conditions, and the shaft is apt to be useless for the economic extraction of the ore; if it be desirable to extract ore for commercial reasons on either side of the shaft, heavy timbering must be done in order to prevent caving from the hanging wall.

At the time when underground work depended upon steam or Cornish pumps, the incline shaft suffered a decided disadvantage, but by the introduction of electric station pumps, and air or electric sinking pumps, it should be possible to carry on work just as rapidly and efficiently in an incline shaft as in a vertical shaft.

In Mexico it is claimed that ore is most successfully extracted from the mine by wheeling the cars directly upon cages and hoisting these to the surface, which, of course, is unfeasible with incline shafts, but in camps outside of Mexico, experience has shown that greater economy is obtained by the use of self-dumping skips, which are handled just as easily and economically in incline as in vertical shafts.

Probably the most advantageous method of shaft sinking in exploration work is to drive an incline shaft at a constant angle in the foot wall, closely following the vein. Only short cross-cuts will be required to tap the vein at frequent intervals, and probably less water will be encountered than in the body of the vein.

Shafts sunk exclusively for drainage purposes are almost entirely sunk

to unwater old workings. If the vein has a flat dip it would seem that the most economic practice would be to sink a vertical shaft at such a point as to strike below the lowest known depth of the old workings, but if it should be desirable to reach a point just below the water level, for the extraction of pay ore, a long cross-cut would be necessary at a cost of much valuable time and labor.

Another objection to the vertical shaft in cases similar to the above, is that if the ore bodies are found to be workable at levels below the point at which the vertical shaft cuts the vein, it would have to be extended into the foot wall, which is typical of standard examples shown in the text books. When the upper levels of the mine are ultimately stoped out, the resulting partial settlement of the hanging wall often develops a bad fracture zone near the point where the vertical shaft intersects the vein, which in some cases has been the cause of endless trouble and expense. As already explained surface topography in relation to the dip of the vein must be a very strong controlling factor in the choice between vertical and an incline shaft.

Shafts which are sunk expressly for the extraction of ore must, of course, be located principally with relation to the main ore shoots and the lateral extent of the vein on either side of the shaft. The mouth of the shaft must also be located with regard to the proposed location of the metallurgical plant. In the case of nearly vertical veins, the vertical shaft is undoubtedly best, and the only other consideration is its location in relation to the above factors.

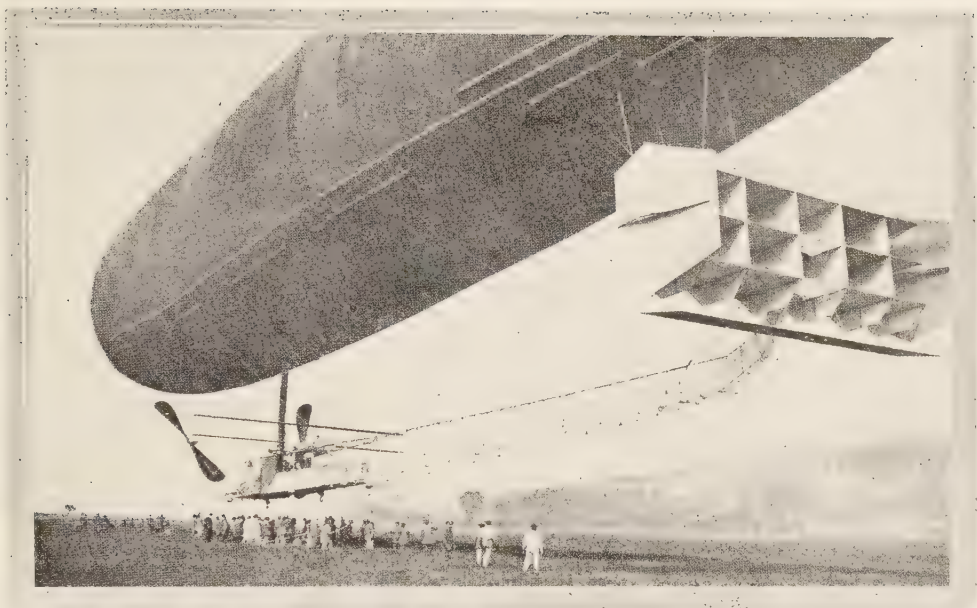
Special cases, however, occur which eliminate all feasibility of the vertical shaft. Two veins with the same outcropping may dip in opposite direc-

tions, and at such an angle with each other that a vertical shaft between the two would require prohibitory cross-cuts to strike either vein; or one vein may be owned by two companies, the first, owning the outcrop, may drive incline shafts, but the second would have to sink a vertical shaft to great depth before reaching the vein, which is known to dip at a comparatively flat angle, and thence drive an incline shaft along the foot wall.

Where, however, the combination shaft can be avoided, it is unquestionably better to put in either an incline shaft on the same constant grade, or a deep vertical shaft; but where the veins change abruptly in dip, or where the dip reverses at great depth, this is almost impossible to accomplish. With the great facilities for underground hoisting stations which now exist, as a result of the perfect electrical equipment which can be installed in mines, the most satisfactory arrangement would seem to be to install a separate discharge and loading point underground.

Large diameter core drills are now being used in the United States for sinking holes in the hanging wall of the vein for ventilating purposes. As the holes drilled with these machines are generally of very large diameter up to 20 inches and even larger, a shot type of core drill is generally used for this work, in which case the holes can only be sunk vertically, and must virtually, therefore, be classified as small diameter vertical shafts.

Where ventilation alone is to be considered, these would certainly be far quicker to put down, and cheaper to drive than any form of standard incline or vertical shaft; and in any case ventilation can be most satisfactorily obtained with a straight well-driven shaft than with the greater length required for the incline shaft.



THE "CLEMENT-BAYARD" AS SEEN FROM THE REAR

THE DIRIGIBLE BALLOON

SOME OF THE PROBLEMS IN MODERN DESIGN

J. H. P. Daman—The Central

THERE is at the present time a widespread feeling that the dirigible balloon or airship is of no practical utility. This feeling is the outcome of two causes, namely, the very bad record of accidents and failures in large dirigibles in the past, and also the enormously rapid improvement in the results obtained with aeroplanes, which last has quite withdrawn public attention from the lighter-than-air vessel.

The essential problem is that of conveyance of a certain paying load over a certain distance at a desired speed, together with ability to keep the air for prolonged periods. To this must be added the most important feature of handiness in manœuvring in and out of sheds, etc.

Resistance, which must, of course, be a minimum, consists of two parts,

head—a dynamic resistance due to progressive displacement of the air from the nose of the balloon—and skin friction. For a given surface the latter is a fixed amount, so that design must aim principally at reduction of the former. The attainment of high speed demands an efficient shape of balloon, and the shape affects the stability in flight, so that the correct determination of shape is of the utmost importance.

It is usual to consider that there are three main types—the rigid, the semi-rigid, and the non-rigid. The classification depends upon the extent to which a framework is used to maintain the shape of the balloon against the various forces which are encountered. Practically it is often difficult to class a vessel. Any classification demands modification for

general use. Quite small airships are often made without any framework at all. The "Parseval," though of large dimensions, is an example of this type. A disadvantage of this type is that, should the internal pressure of gas become for any reason suddenly reduced, the shape of the balloon is at once altered, as also are the stresses in the rigging.

Elongated cars of light girder construction are used to enable the load to be spread over the balloon to a great extent, and so reduce bending effects and also dependence on correct pressure of gas. Examples of this type are the Willows airship and also the "Beta" and "Gamma" of the British War Department. Increase of rigidity may be obtained by hanging the girder close up to the balloon. The car is then slung from the girder instead of being incorporated with it. The *Morning Post* Lebaudy airship was an example of this type. This is also the Gross system of construction. This arrangement necessitates more rigging, hence more resistance. By attaching the girder to the balloon direct it is possible to cover it in and so keep resistance down.

With increase of the ratio of length to maximum diameter, called the fineness ratio, there is an increase of bending moment; this may be met by further additions to the framework, or by spreading the load, or by both. The rigid frame for the balloon together with multiple arrangement of gas bags adopted by Zeppelin is the outcome of this tendency. Owing to the sudden variation of temperature and pressure experienced with a balloon it is unwise to rely upon the maintenance of adequate gas pressure for maintenance of shape at all times; this is especially true of balloons of elongated form.

Until recently the importance of streamline form was scarcely rea-

lized, and badly shaped gas bags fitted with so-called blubber fins have been used to a great extent.

A considerable degree of bluffness is advantageous in the case of gas bags having minimum resistance for a given value of the net life. The limit in this respect has not been exactly determined. It is, however, further in the direction of fulness both for heads and tails than would be imagined.

Long pointed tails have not in general sufficient lifting power for the support of stabilizing planes, so that sagging of the tail occurs; this is especially so when the internal gas pressure is low. Blubber fins, that is small external balloonets attached to the tail, have but little stabilizing action, and by their presence seriously upset the flow of air about the tail of the balloon, and unduly augment the resistance.

In the early French airships the motive power was electrical. The petrol motor is now the only plant employed. Lightened car engines are much used. As long as it is not intended to run at full speed for any prolonged period this is reasonable enough. As requirements alter, the conditions of running will approximate to those of ships' engines in which full speed ahead is demanded for long periods at a stretch. As regards engine weight it is relatively unimportant what the weight per horsepower may be, but it is important what the weight per horsepower-hour may be for long runs. It has been shown that for a run of over 17 hours' duration, the 38-horsepower Daimler engine is actually more efficient than the 50-horsepower Gnome; this on the score of gross weight alone, and not taking account of the relative liability to breakdown.

The use of four-bladed propellers appears to be advantageous. An ar-

rangement used by Willows, by which the propellers can be swiveled into a horizontal plane, is of undoubted value for manœuvring.

The use of steel wire is almost universal; a quality of steel is required which is strong without being hard. As is well known, the air resistance of vibrating wires is high; determinative work is being done on this subject by the National Physical Laboratory. The resistance of various ropes and wires has been carefully investigated by the Gottingen Model Testing Institute. Cars and frames are now almost always of weldless steel tube, and combine strength and tightness to a remarkable degree.

The subject of the correct fabric for airship use is one which does not appear to have reached anything like finality. Rubbered cotton fabrics rapidly lose their gas-holding properties on exposure to weather. As hydrogen delivered in tubes costs anything above £2 per 1,000 cubic feet, this is clearly a serious defect. It has in the past been the practice in France to specify that for new rubbered cotton envelopes the leakage of hydrogen should not exceed

10 litres per square metre per 24 hours. It is reported that improved results have been found with the use of silk impregnated with boiled oil and similar substances.

The use of a very light apparatus for the manufacture of hydrogen, which could be carried by the airship, would obviate the necessity for balloonets, and to a great extent ballast, and would admit of the vessel keeping aloft for longer periods. Attempts have been made to do this, but so far with no marked success. The gas used is always hydrogen.

The lift per 1,000 feet—which is the difference in weight between the air and the hydrogen—is about 70 pounds. The presence of air in the hydrogen has a considerable influence on the lifting power; approximately the drop in lifting power is proportional to the amount of air.

There is still so much experimental work to be done that it is impossible to predict as to what the near future may have in store. The great majority of disasters which have occurred to airships in the past are certainly due to violation of principles of sound design and construction.

THE "TITANIC" INVESTIGATION REPORT

CRITICISM ON SOME OF THE LAWS DRAFTED BY THE SENATE COMMITTEE

Engineering News

UNDOUBTEDLY a certain amount of credit is due the Senate Committee which investigated the "Titanic" disaster, and due praise should be rendered for the untiring energy with which the Committee uncovered every possible detail connected with the sinking of the vessel. But it must be remembered that this Committee was not composed of technical men, qualified by training and experience to

speak authoritatively upon maritime matters, and hence that the laws which the Committee has drafted should be most carefully considered, and referred to expert marine engineers for revision before being adopted.

Certainly out of the mass of technical literature presented since the time of the disaster, there may be found some method of safeguarding against a repetition of just such a

disaster, but, as *Engineering News* points out, it may be a quarter of a century or half a century before another passenger vessel will suffer by collision by an iceberg. In the meantime, however, all the other usual and ordinary causes of marine disaster continue in full force.

In travel by sea, a scheme may appear to the lay man as particularly advantageous to securing additional safety, whereas a marine expert, familiar with the whole field of vessel construction and operation can see at a glance that the device would introduce dangerous complication.

Statistics recently published showed that the proportion of casualty on vessels under United States inspection was one death per 800,000 passengers carried. Were it possible to reduce this rate 50 per cent by doubling the cost of construction, the public would not stand for any such increase in transportation expense.

While vessels in the merchant service could be constructed with the same strength as the modern battleship, yet such a vessel would be so uncomfortable and unpleasant compared with the modern transatlantic liner that passengers without question would choose the latter.

The Committee demands that sufficient lifeboats shall be carried by every passenger vessel to accommodate the entire ship's company. The fact that the "Titanic" had not boats enough to save all her passengers and crew is one on which the public has seized as of greatest importance. As a consequence, passenger vessels the world over are loading their upper decks with a large number of additional lifeboats. The owners and masters of these vessels are doing this because of pressure of public opinion; but so far as the actual

safety of the ship's company is concerned, they know well that increase of safety by this additional provision of lifeboats is at best problematical.

The loss of the "Titanic" took place under abnormal conditions. There is not one day in a fortnight on the average in the North Atlantic, perhaps not one in a month, when boats could be launched and filled with passengers from a vessel of the size of the "Titanic" under the conditions which prevailed on that vessel, without a large loss of life. Lifeboats for the crew of a tramp steamer, used to a sea-faring life and exposure to hardships are one thing; but they are quite a different thing as a means of rescue for the many hundred men, women and children which crowd the decks of a modern transatlantic liner.

It is well recognized by sea-faring men that a lifeboat is merely a last hope when the vessel itself is doomed. Properly speaking, the lifeboat is not a "safety" appliance. It affords only a chance of saving life after all other hope has failed, but it is a chance at best and not seldom it proves a hopeless chance.

Instances without number could be multiplied, all tending to show that the menace of fire as a danger to travel by sea is probably many times as great as any danger from floating ice. The bearing of this upon the present agitation and proposed legislation compelling the carrying of an enormous number of lifeboats ought to be sufficiently obvious. To cover the entire top deck of a vessel with a large number of boats, covered as they must be with heavy coats of paint, would furnish ideal conditions for the spread of a fire once started on any part of a vessel over its entire length.

It may be recalled that there were numerous suggestions in the news-

papers, when the "Titanic" disaster was filling everyone's mind, that all ocean vessels should carry lifeboats propelled by gasoline engines. It was declared that nothing but the brutal disregard of human life had caused the steamship companies to adhere to the old-fashioned method of oars and sails as means of propulsion for lifeboats. Plenty of people at that time would have voted vociferously without doubt for a law to compel every steamship to be equipped with gasoline launches sufficient to accommodate the entire ship's company. But an expert who understands the relative importance of different dangers at sea would avoid shipping on such a vessel as he would avoid a pestilence.

Another illustration of the care necessary in framing any requirements for safety in vessel construction or operation is the provisions of the bill regarding the bulkhead division of vessels. According to press reports, the bill requires every steel steam vessel on the ocean or the Great Lakes to have an inner watertight skin in the form of an inner bottom or of longitudinal watertight bulkheads. It is not clear from this statement whether a central longitudinal bulkhead, such as was formerly installed in vessels, would be sufficient to fill the requirements. If so, it should be said that such a longitudinal bulkhead is now considered by most naval and marine architects to be rather a source of danger than of safety. If a transverse compartment is flooded on one side of the longitudinal central bulkhead and not on the other, it gives the ship a dangerous list which may bring her water line so low on the lower side as to cause the loss of the vessel when she might continue to float on an even keel.

Again, each vessel is required to

be equipped with two electric searchlights. It is at least open to debate as to whether the use of such searchlights by a vessel on the high seas would be a source of greater safety or danger. Suppose they were used habitually at night to illuminate the path of the vessel for a long distance ahead. Watchers on the bridge and in the crow's nest would naturally follow the path of the beam of light. Their eyes would thus become unable to discern anything in the surrounding darkness.

Again, there is the matter of furnishing binocular glasses to the men in the crow's nest. There is good reason to believe, however, that to allow the lookout men the use of such glasses would contribute more to danger than to safety. Every engineer familiar with the use of telescopes and binoculars knows that their steady use unfits the eyes for ordinary vision for several minutes afterward. While it is proper enough for the officers on the bridge to have such glasses, as they always do, there are many vessel owners and navigators who would hesitate to place such glasses in the hands of the men in the crow's nest.

Senator Smith's report blames the general officers for not sounding a general alarm as soon as they knew the serious condition of the ship. Rather they should be praised for their steady nerve and sound judgment in quieting, so far as possible, all alarm and excitement. It needs but the slightest knowledge of human nature to realize that had a general alarm been sounded throughout the doomed vessel, had all the crew and the passengers from the first cabin to the steerage been told that the ship was doomed, there would have ensued a panic which the officers themselves would have been powerless to stay.

UTILIZING FLUE-DUST

CONDITIONS FOR THE RECOVERY OF VALUE AND OUTLINES OF METHODS

Felix A. Vogel—American Institute of Mining Engineers

FLUE-DUST is generally a fine material containing considerable coke and iron-ore, with a small admixture of lime and silica, depending upon the burden. The iron-ore being partly reduced indicates that the dust originates largely in the reducing zone of the blast-furnace.

With the increasing use of fine ores, larger furnaces, and high pressure blast, the production of flue-dust is constantly increasing, and amounts annually in the United States to about three and a half million tons, an exceedingly high tonnage, of which a large part has been discarded as valueless.

In the United States this dust usually contains 20 per cent of coke and more than 40 per cent of iron. Estimating coke to be worth \$3.25 per ton, and iron-ore 7 cents per unit, a ton of flue-dust represents a loss to the furnace man of \$3.50. This accounts for the first efforts to recharge the flue-dust into the furnace, either by moistening it down with an excess of water, or mixing it with clay to form balls of pulp, or treating it with lime-water. These methods have been practically discarded, as they failed to produce the desired economies.

To recover in the blast-furnace all the values represented by the material contained in the flue-dust, the following conditions should be complied with:

1. The dust should be agglomerated into lumps about the size of furnace-coke, so that it will help to carry the burden and facilitate the flow of the gases.

2. The agglomerated material should be strong enough to carry the burden without disintegrating; it should be heavy, so as to decrease its volume, and it should be sufficiently porous to permit the furnace-gases to penetrate fully. Under no condition should the surface be glazed.

3. It should contain all of the valuable constituents of the dust, such as coke, iron-ore, lime, etc.

4. It must stand handling, without undue breakage, and should not produce more than 5 per cent of dust.

5. It must stand the weather.

6. It must not disintegrate in the blast-furnace before being greatly or totally reduced.

7. It must submit to easy reduction without requiring additional fuel.

8. It must not contain substances detrimental to blast-furnace operations.

9. Its production cost must be low.

A number of processes have been evolved in the United States, generally known as agglomerating and sintering processes. They are based on fritting together the particles of ore by heat, the binding action being due to the formation of silicates, mostly of iron.

The nodulizing process has been in successful operation for a number of years. Flue-dust is either treated directly or it is previously submitted to a magnetic separation to eliminate coke and lime. This is done in order to facilitate the subsequent nodulizing operation, which is carried on in a slowly rotating cement-kiln from 80 to 120 feet long. From 200 to 300 pounds of pulverized coal is used per ton of finished material,

the coal being blown into the kiln. Gas and oil in place of coal have also been tried with more or less success.

The heat produced is high and difficult to control. The semi-soft material formed consists of iron-ore particles and slag, which, by the revolving action of the kiln, is balled together in nodules of various sizes, usually quite dense, often fused and glazed.

The Huntington-Heberlein pot process, which has been used with good results in the roasting of pyrite-cinders, has been recommended for the fritting of flue-dust. The resulting fritted material is of more or less cellular structure, which is not, however, an advantage, as the surface would be largely glazed, rendering it impermeable to gases, and requiring its removal in the blast-furnace at about smelting heat. The process is somewhat simple, requiring stationary iron pots fitted with a perforated false bottom through which the air is blown into the charge. The equipment is cheap, but the operation is not continuous, thereby increasing the cost.

The Gröndal briquetting process has also been applied to flue-dust. The flue-dust, either moistened or after the elimination of coke and stone, is pressed into bricks, which are subsequently fritted in high temperature. To facilitate the operation it was found necessary to eliminate the coke; this, however, increases the cost. The separated coke is of little value, since it contains many impurities. The presses used are ordinary brick-presses. The bricks are carefully placed in layers on cars, which are run into long kilns about 170 feet long, where they are submitted to high heat, gas being used for the purpose. The platforms of the cars are built of fire-brick and form the bottom of the

kiln. The highest temperature, about 1,300° or 1,400° C., is reached in the center of the kiln, the highly-burned briquettes working gradually towards the cooler end of the kiln, where they are finally unloaded. The operation lasts about 7 hours. The resultant briquettes contain from 65 to 70 per cent of iron with practically no impurities, these having been eliminated. No ashes are left by the fuel. The briquettes are only slightly fritted, are very porous and friable, and make a high-class material for use in an open-hearth furnace. The manufacture of Gröndal briquettes is expensive, necessitating a costly plant, which has limited output. A ton of flue-dust will produce about two-thirds of its weight in briquettes.

Quite recently the Dwight-Lloyd process has been applied to the sintering of flue-dust. The material is submitted to internal combustion in layers from 5 to 7 inches thick. It is fed on an endless conveyor formed of iron pallets or grates. After the fuel contained in the flue-dust has been ignited by means of a gasoline torch, or some other device, the air is drawn through by suction. The operation lasts about 20 minutes. It is claimed that the required plant is not costly, while the operating-expenses are considerably lower than in the previous process.

The sintered material from these various processes is expensive on account of the loss of carbon, and, with the exception of the Gröndal briquette, is not of good physical structure and is usually glazed on the surface.

The briquetting of flue-dust has been more attractive abroad than has the sintering.

The lime process mixes the flue-dust with from 5 to 10 per cent of hydrate of lime. After briquetting,

the material is exposed to the air for a certain length of time, so that a carbonate is formed, which is the binding medium. This binder will eventually act as flux and replace a certain amount of stone. The process, while having decided advantages, is quite cumbersome and costly, as the briquettes must dry from two to four weeks under cover.

The Ronay process does not use a binder. The flue-dust is submitted to a very high pressure in a specially constructed type of hydraulic press; the resulting briquettes can be handled immediately and have proved very satisfactory. The process requires an expensive plant, however, increasing the operating cost.

The Schumacher process does not use what may properly be called a binder, but is based on the latent cementing actions existing in fresh flue-dust and which are made active

by the presence of a small amount of a catalytic substance. Thus 0.25 per cent of magnesium chloride mixed with fresh flue-dust and from 6 to 10 per cent of water, pressed into briquettes, will create a strong reaction, noticeable by the considerable heat developed; the briquettes will be perfectly set and hard within a few hours. The process is very simple, an ordinary pug-mill being used in which to mix the material, which is subsequently pressed into briquettes in a toggle-press and then loaded on cars to allow them to set.

The Schumacher process requires an inexpensive plant and the cost of manufacture is low. It is extensively used abroad and has replaced some of the other methods. The briquettes of all agglomerated materials have given most satisfactory results abroad with high returns and values to the blast-furnace operators.

ALLOYS OF ALUMINUM AND ZINC

AN OUTLINE OF THE TENTH REPORT TO THE ALLOYS RESEARCH COMMITTEE

Dr. Walter Rosenhain and S. L. Archbutt—Institute of Mechanical Engineers

FROM the point of view of practical use, the aluminum-zinc alloys have received considerable attention. For casting purposes the fact that an addition of zinc to aluminum facilitates the production of sound castings is widely recognised; at the same time, these alloys are credited with undesirable properties in two important directions. The first of these is the tendency which they are said to possess to crack in cooling, particularly if the castings are of a shape liable to that form of defect. Further, the alloys are generally regarded as being liable to rapid corrosion, and actual examples of such corrosion have

come under the notice of the authors in the case of industrially prepared alloys.

As regards corrosion, experiments and tests indicated that the alloys as prepared by the authors are by no means liable to the severe and excessive corrosion which the general reputation of the alloys would lead one to anticipate. It was supposed, and experiment has justified the supposition, that the rapid corrosion of many commercial samples of aluminum-zinc alloys is due to the presence of impurities derived from the spelter employed in their manufacture. Test alloys, prepared from pure zinc, behaved more satisfactorily.

With regard to the mechanical properties of the aluminum-zinc alloys the statement is sometimes found that they are particularly weak under the action of vibratory stresses and of shock. Here again the results of the experimental research do not confirm this previously held view; exhaustive tests under shock and alternating stresses clearly showed that these alloys are not abnormally weak in this respect, and that in effect they exhibit properties in these circumstances which are in normal correspondence with their general mechanical behaviour.

As regards the general mechanical properties of the aluminum-zinc alloys, the outstanding result of the experimental research is perhaps to be found in the very large effect produced upon them by hot work. It has been found possible to roll out into bars and even to draw into wire an alloy containing as much as 25 per cent of zinc in spite of the fact that this same alloy in the sand-cast condition shows no perceptible ductility. This alloy attains its maximum tensile strength when in the condition of rolled bar $1\frac{1}{4}$ inches in diameter, the maximum stress being 27.5 tons per square inch. It is very interesting to find that rolling down the same alloy to $\frac{7}{8}$ -inch diameter while hot, so far from improving the properties of the material, brings about a reduction in the tensile strength of several tons per square inch, and similar phenomena are met with throughout the whole series of alloys. It may be added here that by the addition of a small percentage of copper to these aluminum-zinc alloys the tensile strength of the hot-rolled material may be raised to 32 tons per square inch while retaining a reasonable degree of ductility. In the form of wire the maximum tensile strength obtained is 34 tons

per square inch. The specific gravity of alloys having these high tensile strengths lies in the neighbourhood of 3.2, so that they may still fairly be regarded as light alloys; in comparison with other light high-tensile alloys containing magnesium, the present series have the advantage that no special heat treatment or quenching is required to develop their special properties.

Both the binary and ternary alloys just referred to differ in one important respect from the majority of non-ferrous alloys by the fact that in the rolled condition they exhibit a definite and well-marked yield-point, their behaviour in the testing-machine showing the sudden dropping of the beam which is familiar in the testing of mild steel. This behaviour may perhaps justify greater confidence in the properties of these alloys than that which engineers usually repose in materials having a gradual indefinite yield.

The most important point in the application of aluminum-zinc alloys is that the alloys richer in zinc, namely those containing from 15 to 20 per cent. of zinc (with or without the addition of copper), are deserving of much closer attention and of more widespread use as compared with the lower alloys, containing less than 15 per cent of zinc, which are much more widely used in present practice. If dynamic as well as tensile tests are taken into consideration, experiment showed that the alloy containing 20 per cent of zinc is the most generally useful of the simple binary alloys.

Mention must be made of what is probably the most serious defect of this group of alloys, namely, their great sensitiveness to rise of temperature in relation to their tensile strength. Thus the alloy containing 25 per cent of zinc, whose tensile

strength at the ordinary temperature is 27.5 tons per square inch, at a temperature of 100° centigrade, has a tensile strength of only 18.5 tons per square inch, and the rapidity of this drop in strength with rising temperature increases as the temperature is further raised. When very hot the alloys are accordingly very weak, but while they are brittle to shock and cannot therefore be forged at temperatures much above 400° centigrade, in the testing machine they still exhibit an exceptional amount of ductility. It is this somewhat abnormal behaviour which makes it possible to roll into bars alloys which are brittle in the cast state, but at the same time it renders an accurate control of the rolling temperature an essential condition of success.

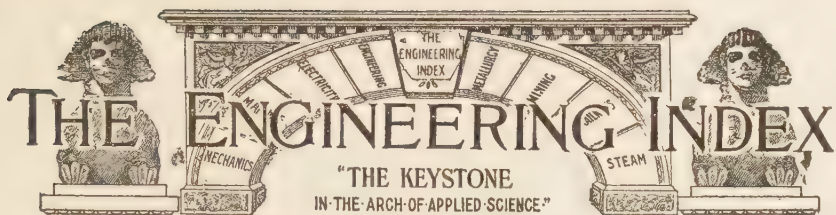
Tensile tests at high temperatures were made on a series of the alloys in order to ascertain the effect of zinc-content on the rate of loss of strength of these alloys with increasing temperature. Most of the alloys were tested up to 200° centigrade, but in two cases considerably higher temperatures were employed (up to 595° centigrade). In every case it is found that there is a rapid fall in the yield-stress and ultimate stress with rising temperature, even 50° centigrade producing a marked effect. The rate of loss of strength varies according to the composition of the alloy; thus at 100° centigrade the alloys containing up to 13 per cent of zinc lost about 36 per cent of their tensile strength at the ordinary temperature; the alloys containing from 15 to 17 per cent showed a loss of 44 to 52 per cent. These relative rates of loss were confirmed at higher temperatures. At still higher temperatures the strength of the alloys becomes exceedingly small, but they exhibit a remarkable degree of ductility as measured by elongation and

reduction of area; the latter in some cases is so great that the fracture is drawn down to a sharp point, while the elongation in one instance reached 133 per cent.

In view of the results of all mechanical tests the authors arrive at the conclusion that an alloy containing about 20 per cent of zinc probably represents the best combination of properties obtainable in the simple binary aluminum-zinc series.

Corrosion tests on specimens of these alloys exposed to the sea were carried out for a period of over 500 days, and the results showed that the rate of loss of weight under such exposure increases with increasing zinc-content. The actual rate of loss, however, is not as great as might have been anticipated, varying, when allowance for the differences of density is made, from 1½ times that of Naval Brass to 1½ times that of Muntz Metal. The authors, however, regard their corrosion tests as purely preliminary, since the alloys were used in the cast state, while subsequent study suggests that annealed material would show considerably less corrosion. The method of measuring corrosion by loss of weight is also regarded as inadequate for the study of these alloys, and further corrosion tests are being undertaken.

A general feature of some importance in connection with the alloys, and particularly with those containing from 10 to 30 per cent of zinc, is the great facility with which they can be worked by machine tools of all descriptions, in most cases without the use of any lubricant. Turnings of exceptional length and strength have been obtained from several of these alloys. The machined surfaces retain their brightness in the air of the laboratory for many months without protection of any kind.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

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- (3) A descriptive abstract,
- (4) Its length in words,
- (5) Where published,
- (6) When published,
- (7) *We supply the article itself, if desired.*

The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES

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The Elasticity of an Arch-Stone (Étude Élastique d’un Voussoir). M. Bonneau. Mathematical discussion on the strength of, and force exerted against the keystone. Diagrams. 40 pp. *Ann d Ponts et Chaussées*—March-April, 1912. No. 33588 E + F.

Causeways

The Galveston Causeway. Meigs O. Frost. Illustrated description of this recently completed structure of earth, steel and concrete crossing. Galveston Bay. 1800 w. *Sci Am*—June 29, 1912. No. 33987.

Falsework

Construction of the Montezuma Bridge. The double-track line of the West Shore R. R. crosses the N. Y. State Barge Canal at this point. Describes successive falsework operations to provide for building piers and erecting superstructure while maintaining traffic. Ills. 1800 w. *Eng Rec*—June 1, 1912. No. 33297.

Highway Bridges

See Viaducts, under *Bridges*.

Ouse Bridge

The History of the Ouse Bridge. Illustrated account of this old English bridge, and the various structures related

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to it. Plate. 1400 w. Builder—May 17, 1912. No. 33254 A.

Pontoon

Ferro-Concrete Sludge-Pumping Pontoon; Manchester Ship Canal. W. Noble Twelveteers. Illustrated general description of the arrangement and mechanical equipment, and of the construction. 2000 w. Engng—June 14, 1912. No. 33938 A.

Quebec

Remarks on the Quebec Bridge, and a Proposed Cantilever Design. C. A. P. Turner. Gives an outline sketch and general description of the author's design. 3000 w. Eng News—May 30, 1912. No. 33318.

Reconstruction

Bridge Building on Sedgemoor. R. Morton Stone. Illustrated account of the rebuilding of bridges near Glastonbury, of interest because of the means adopted to secure stable foundations. 2000 w. Surveyor—June 14, 1912. No. 33930 A.

Reinforced-Concrete

The Highway Bridge over the Enz in Pforzheim (Die Rossbrücke über die Enz in Pforzheim). A. Kleinlogel. Details in the construction of this bridge. Ills. Serial. 1st part. 2400 w. Beton u Eisen—May 8, 1912. No. 33519 E.

Reinforced Concrete Bridge over the Muota at Hinter-Ibach (Eisenbetonbrücke über die Muota in Hinter-Ibach.) H. Gubelmann. Detailed description of arched highway bridge, with span of 118 feet. Ills. 1500 w. Schweiz Bau—June 1, 1912. No. 33545 D.

Susquehanna River

Deck Spans of Susquehanna River Bridge. Illustrated detailed description of features of the bridge at Havre-de-Grace. 1500 w. Eng Rec—June 8, 1912. No. 33623.

Suspension

Suspension Bridge over the Inn at Brail (Hängesteg über den Inn bei Brail). Details of a temporary construction bridge for the Phäetian Railway in Switzerland. Ills. and plans. 1000 w. Schweiz Bau—May 11, 1912. No. 33522 D.

Viaducts

Viaduct Approach of Cellular Type. S. W. Bowen. Illustrates and describes a cellular type of construction for a reinforced concrete viaduct, giving details of cost. 2500 w. Eng News—May 30, 1912. No. 33320.

Kingshighway Viaduct, St. Louis, Mo. Mont. Schuyler. Illustrates and describes a large concrete structure forming a part of the city boulevard system. 6000 w. Eng News—June 27, 1912. No. 34113.

The Tunkhannock Creek Bridge on the Lackawanna Railroad. Illustrated description of a concrete bridge to be built near Nicholson, Pa., the largest ever built for railway purposes. 600 w. Eng News—June 13, 1912. No. 33706.

Street Bridge Over the Great Northern Ry. Tracks in Minneapolis. O. B. Robbins. Drawings and description of three overhead street crossings of interesting designs. 2000 w. Eng News—June 20, 1912. No. 33858.

CONSTRUCTION

Building Failure

The Collapse of the Neilson Building. Illustrated account of a failure in Toronto of a factory building having three stories added. 3500 w. Can Engr—June 20, 1912. No. 33906.

Buildings

The "Friedenskirche" in Offenbach and Its Construction (Die Friedenskirche in Offenbach a M. und ihre Konstruktion). Herr Steinberger. Details in the construction of this church of reinforced concrete. Ills. 3200 w. Beton u Eisen—May 28, 1912. No. 33548 E.

Columns

Concrete Column Economics. J. Norman Jensen. An investigation of types of reinforced concrete columns, reaching the conclusion that cement is the best reinforcement. 3500 w. Eng News—June 6, 1912. No. 33490.

Concrete

Unit Wall Concrete Building Construction, Fort Crockett, Texas. R. C. Hardena. Illustrated description of the Aiken system of flat wall construction, explaining its advantages. 1500 w. Eng News—June 27, 1912. No. 34109.

Deering Works. W. D. Price. Illustrated description of a new concrete factory building for the International Harvester Co. 1200 w. Cement & Engng News—June, 1912. No. 33762.

See also Columns, under *Construction*; Concrete, under *Materials of Construction*, and Tanks, under *Water Supply*.

Crushers

See same heading, under MINING AND METALLURGY, *Ore Dressing and Concentration*.

Demolition

Demolition by Explosives at Port Talbot. Illustrated account of methods used in removing heavy and deep concrete foundations and a huge accumulator tower of brickwork in best grouted cement. 1000 w. Engr, Lond—June 7, 1912. No. 33793 A.

Drilling

A Cost and Time Study of Drilling Blast Holes with Well Drills. From a paper by R. R. Sanderson, read at meeting of the Natural Lime Mfrs. Assn. 5000 w. Engng & Con—June 5, 1912. No. 33481.

See also same heading, under MINING AND METALLURGY, *Mining*.

Electrolysis

Electrolysis Investigation and Ordinance at Chicago. Information concerning tests on the Mandel Building and the proposed ordinance to prevent damage by

electrolysis. 2000 w. Eng News—June 6, 1912. No. 33491.

See also Corrosion, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Estimates

The Use of Charts in the Preparation of Estimates. Edward G. Fiegehen. The methods advocated are applied to the preparation of estimates for electric crane work, but can also be applied to other work. 2500 w. Engng—June 14, 1912. No. 33937 A.

Method of Making Rapid Cost Estimates for Crib Pier and Breakwater Construction. Gives the method developed and described by G. A. M. Liljencrantz. Ills. 1500 w. Engng & Con—June 5, 1912. No. 33479.

Fence Posts

Concrete Fence Posts on the Burlington Lines. Notes from a paper by H. L. Hotchkiss, describing the reinforced concrete fence posts used. Ills. 1500 w. Eng Rec—June 22, 1912. No. 33880.

Fireproof

The Enormous Fire Waste of the United States. John L. Cochrane. Discusses bad construction as a cause of fire loss. Ills. 3000 w. Sci Am—June 15, 1912. No. 33716.

See also Roofs, under *Construction*.

Floors

Floors and Floor Construction for Manufacturing Plants. Henry Grattan Tyrrell. This first of two papers considers materials and types suited to ground levels of factories and shops. Ills. 5000 w. Engineering Magazine—July, 1912. No. 33968 B.

Foundations

The Large Pneumatic Foundations of the New York Telephone Building. Illustrates and describes the underpinning of large pneumatic caisson concrete piers with footings in sand and gravel. 2200 w. Eng Rec—June 1, 1912. No. 33296.

Granaries

See Dock Machinery, under *Waterways and Harbors*.

Hydraulic Filling

Cost of 735,425 cu. yds. of Hydraulic Dredge Fill for the Extension of Lincoln Park, Chicago, Ill. Describes the work and gives itemized costs. Map. 900 w. Engng & Con—June 5, 1912. Serial. 1st part. No. 33480.

Piers

A Pier Built on Cylinders Cast as Concrete Shells and Filled in Place. H. L. Muchemore. Illustrated account of shells made on shore and sunk as open caissons at Puget Sound Navy Yard. 2500 w. Eng Rec—June 22, 1912. No. 33878.

Piling

Strauss Piling Foundations in Switzerland (Strausspfahlgründungen in der Schweiz). Herr Kersten. An account of some of the constructions built upon the Strauss patented knobby concrete

pilings. Ills. 2800 w. Schweiz Bau—May 18, 1912. No. 33523 D.

Retaining Walls

See Canals, under *Waterways and Harbors*.

Roofs

Roof Construction a Factor in Fires. Gives examples of roofs of different materials and their parts in checking or spreading fires. Ills. 1000 w. Met Work—June 7, 1912. No. 33601.

Calculations for Roof Constructions (Zur Berechnung der Deckenkonstruktionen). R. Maillard. Theories and mathematical determinations. 3500 w. Schweiz Bau—June 1, 1912. No. 33546 D.

Silos

Grain Silo in the Harbor of Rosario (Getreidesilo im Hafen von Rosario). E. Luft. Detailed description of this grain storage in one of the leading ports of the Argentine Republic. Map and ills. Serial. 1st part. 4000 w. Zeitschr d Ver deutscher Ing—May 11, 1912. No. 33572 D.

Submarine Excavation

See same heading, under *Waterways and Harbors*.

Tunnels

Determination of Probable Rock Temperature in a Continental Divide Tunnel. E. Lauchli. A study for a deeply overlaid six-mile railroad tunnel in Colorado. 4000 w. Eng Rec—June 8, 1912. No. 33618.

Methods of Alignment in Three Aqueduct Tunnels. Descriptions of methods used on the Yonkers pressure tunnel, the Van Cortlandt pressure tunnel, and the Wachusett aqueduct tunnel. 3500 w. Eng News—June 20, 1912. No. 33862.

Methods of Constructing the Sand Patch Tunnel of the Baltimore and Ohio Railroad, with Records of Progress. Illustrated description of work in making a second bore through the summit of the Alleghany Mts. to relieve congestion. 1800 w. Engng & Con—June 26, 1912. No. 34102.

Notes on the Laramie Tunnel Discussion of the paper of David W. Brunton. 3000 w. Bul Am Inst of Min Engrs—June, 1912. No. 34054 F.

Lining Part of the Bonlicou Grade Tunnel. John H. C. Gregg. Illustrates and describes methods followed in a rock tunnel on the Catskill aqueduct. 3000 w. Eng Rec—June 22, 1912. No. 33879.

The Influence of Rock Pressures upon Deep Horizontal Tunnels (Der Einfluss des Gebirgsdrucks auf einem tief im Erdinnern liegenden Tunnel). Karl Brandau. Discussion on various theories of earth pressure, and practical points in construction. Ills. 4200 w. Schweiz Bau—May 25, 1912. No. 33524 D.

Tunnel Ventilation

Ventilating Equipment of the Pennsylvania Tunnels at New York. B. W.

Bennett. Brief description of the forced draft system, with results of some of the tests. 700 w. Eng Rec—June 8, 1912. No. 33620.

MATERIALS OF CONSTRUCTION

Brick

The Manufacture of Sand-Lime Brick in Europe. P. L. Simpson. An account of plants visited during a recent trip. Ills. 6000 w. Cement & Engng News—June, 1912. No. 33761.

Cement

Autoclave Boiling Test for Cement. H. J. Force. Describes a new soundness test for cement, inaugurated by the Lackawanna R. R., and the behavior of the material. Also editorial. 6000 w. Eng News—June 13, 1912. No. 33707.

Cement Grinding. L. H. Sturtevant: Illustrated description of a cement grinding unit, explaining its advantages. 1500 w. Met & Chem Engng—June, 1912. No. 33419 C.

Free Lime in Portland Cement. H. E. Kiefer. Read before the Am. Chem. Soc. Presents results of tests and states points worthy of consideration. 2500 w. Chem Engr—June, 1912. No. 33959 C.

Methods of Testing Coatings for Cement Surfaces. Cloyd M. Chapman. Gives recommended tests of concrete waterproofers and damp-proof concrete coatings. 2500 w. Eng Rec—June 1, 1912. No. 33295.

Concrete

Concrete Mixing. Considers the methods whereby the constituents can best be brought together so as to bind pebbles or fragments of stone to form an artificial variety of rock akin to conglomerate. 1200 w. Builder—May 31, 1912. Serial. 1st part. No. 33656 A.

Consistency and Time in Mixing Concrete. H. F. Porter. Discusses the proper mixing and the importance of time and the proper consistency. 2000 w. Cement Age—June, 1912. No. 33952.

See also same heading, under *Construction*.

Corrosion

See same heading, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Cross-Arms

Strength Tests of Cross-Arms. Thomas R. C. Wilson. Illustrated report of tests and results. 3000 w. U. S. Forest Serv., Circ. 204—June 5, 1912. No. 33807 N.

Reinforced-Concrete

New Building By-Law for Toronto. Gives text of a new by-law regulating reinforced concrete construction. 4500 w. Can Engr—May 30, 1912. Serial. 1st part. No. 33334.

Methods of Designing a Reinforced Concrete Settling Basin for the Muskogee, Oklahoma, Water Works. From a paper by Alexander Potter before the Am. Water Works Assn. Describes the

designing of the reinforced concrete work. 4000 w. Engng & Con—June 12, 1912. No. 33702.

The Artificial Mountains in the Metropolitan Zoological Gardens in Budapest (Die künstlichen Berge des hauptstädtischen Tiergartens in Budapest). Josef Schmaus. General description of the artificial landscape of reinforced concrete introduced in these gardens. Ills. Serial. 1st part. 2000 w. Beton u Eisen—May 8, 1912. No. 33518 E.

A Swimming Pool with Underlying Storage Rooms (Schwimmbassin mit unterliegendem Speicherbassin). Karl Rössle. Details of reinforced concrete tank with a sloping bottom which forms the ceiling of a store-room below the pool. Ills. 2500 w. Beton u Eisen—May 28, 1912. No. 33550 E.

Calculations on Reinforced Concrete Cisterns (Statische berekening van gewapend beton-regenbakken). W. M. Dudok. Mathematical discussion. Diagrams. 7000 w. De Ingenieur—May 11, 1912. No. 33583 D.

See also same heading, under *Bridges*; Fence Posts, under *Construction*, and Docks and Locks, under *Waterways and Harbors*.

Reinforced-Concrete Beams

The Economical Design of Reinforced Concrete Beams. Abstract of an article by R. B. Ketchum, in a bulletin of the Univ. of Utah, giving tables, diagrams and design studies of beams. 2500 w. Engng & Con—June 26, 1912. No. 34105.

Reinforced Concrete Beams. Ewart S. Andrews. Comparison of calculations with those for steel beams. 700 w. Prac Engr—May 31, 1912. No. 33665 A.

Reinforcement

Calculations for Double-Reinforced Construction (Die Berechnung von doppelt bewehrten Konstruktionen). L. Landmann. Mathematical discussion especially considering double reinforcing in concrete beams and columns. 5600 w. Beton u Eisen—May 28, 1912. No. 33549 E.

Sands

A Proposed Study of Concrete Sands. John R. Freeman. Calls attention to the peculiar behavior of certain kinds of sand and urges a thorough scientific investigation. Also editorial. 4500 w. Eng News—May 30, 1912. No. 33321.

Timber

Free Use of Timber From Public Lands. T. D. Woodbury. Gives the amendatory acts controlling such use, with explanations. 2500 w. Min & Sci Pr—June 15, 1912. No. 33850.

The Preservation of Mine Timbers. E. W. Peters. Discusses investigations made to determine suitable methods of treating timber, and the durability of treated and untreated timber in service. Ills. 27 pages. U S Dept of Agr., Bul 107—May 31, 1912. No. 33799 N.

Timber Waste

How We Can Utilize \$250,000,000 Worth of Wasted Timber. An illustrated account of the development of a new American industry, and the uses made of this material. 2500 w. *Sci Am*—June 15, 1912. No. 33714.

MEASUREMENT**Drafting**

Sunshine and Shadow. J. R. Hoffert. Deals with the determination of the shadow lines of buildings. Ills. 1200 w. *Cornell Civ Engrs*—June, 1912. No. 34014 C.

Laboratories

The Function of the Laboratory in the Training of an Engineer. E. W. Marchant. Read before the Liverpool Engng Soc. Discusses the value of laboratory training and its limitations. 3000 w. *Mech Engr*—June 14, 1912. No. 33932 A.

Engineering Laboratories at Liverpool University. Describes the new building and its equipment. 1500 w. *Engr, Lond*—May 17, 1912. Serial. 1st part. No. 33278 A.

The Harrison-Hughes Engineering Laboratories at Liverpool University. Illustrates and describes these new laboratories and their equipment. 4000 w. *Mech Engr*—May 24, 1912. No. 33452 A.

The Murray Laboratory of Mining Engineering, Halifax, Nova Scotia. F. H. Sexton. From an official report. Description of the building and its equipment. 2500 w. *Can Min Jour*—June 15, 1912. No. 33853.

Photo-Surveying

Stereographic Measurement. G. R. Anderson. On the use of photographs in surveying, discussing the problem of deducing measurements. Ills. 1500 w. *Ap Sci*—May, 1912. No. 33645 C.

Stream Gauging

Stream Measurements. Abstract of a report by P. M. Sauder, on the stream measurements in Alberta, Sask., describing methods used. Ills. 7000 w. *Can Engr*—May 30, 1912. No. 33332.

Surveying

Methods and Cost of Making Subdivision on Topographical Survey for Sunnyside Unit, Yakima Project, U. S. Reclamation Service. W. E. Whittier. Describes the work. 8000 w. *Engng & Con*—June 12, 1912. No. 33703.

The Reconnaissance Survey for the Denver & Rio Grande R. R.: Recollections of an Old-Time Engineer. Augustine W. Wright. 2500 w. *Eng News*—June 27, 1912. No. 34115.

MUNICIPAL**City Planning**

How City Planning Bills Are to Be Paid. Nelson P. Lewis. Read at the Boston conference. A discussion of the general principles that should govern the

distribution of cost. 4500 w. *Eng Rec*—June 8, 1912. No. 33622.

Competition for a Building Plan of the Waidareals in Zurich (*Wettbewerb für einen Bebauungsplan des Waidareals in Zürich*). Illustrated description of some of the plans presented for this project. 1500 w. *Schweiz Bau*—May 4, 1912. No. 33521 D.

Incinerators

Water Heating by Garbage Burning. Illustrates and describes types of modern garbage and waste incinerators, explaining their value, efficiency and safety. 2800 w. *Met Work*—June 21, 1912. No. 33864.

Municipal Work

Ten Years of Municipal Work in Nun-eaton, Eng. Reviews the development during the past decade, showing the great amount of work accomplished. Ills. 7000 w. *Surveyor*—May 17, 1912. Serial. 1st part. No. 33269 A.

Refuse Destructor

A 60-Ton Refuse Destructor at Montgomery, Ala. John Primrose. Illustrated description. 800 w. *Eng News*—June 20, 1912. No. 33860.

See also Incinerators, under *Municipal*.

Refuse Disposal

Modern Refuse Disposal Plants. Abstracts from the report of Messrs. Hering and Gregory to the city of Toronto, giving information concerning several of the newest plants. 2500 w. *Munic Jour*—May 30, 1912. No. 33311.

Sanitation

Sanitary Research: A Suggestion. T. L. Hinckley. Remarks on the present day conditions and tendencies, and the matters included in the field under discussion. 1200 w. *Munic Jour*—May 30, 1912. No. 33310.

Water and Sewerage Systems. G. H. Altham. Brief review of public water supply development and its uses, and also the sewerage system. 1200 w. *Can Engr*—June 20, 1912. No. 33910.

Scotland

Stirling and Its Municipal Works. A. H. Goudie. Read before the *Munic & Co. Engrs*. Brief descriptions of the water-works, sewers, streets, refuse disposal, public buildings, etc. General discussion. Ills. 10000 w. *Surveyor*—June 14, 1912. No. 33929 A.

Sewage Disposal

Automatic Apparatus for Sewage Disposal Works. Weston Gavett. A resumé of two investigations. Ills. 6000 w. *Cornell Civ Engr*—June, 1912. No. 34013 C.

Notes on the Digestion of Sewage Sludge. Charles Saville. Discusses the relative advantages of the separate sludge digestion tanks and the Imhoff tanks. 3000 w. *Eng News*—May 30, 1912. No. 33325.

The Digestion of Sewage Sludge. Charles Saville. Considers the relative

advantages of the separate sludge digestion tanks and the Imhoff tanks. 2500 w. Can Engr—June 13, 1912. No. 33728.

The Struggle with Sewage Sludge. William Naylor. Discusses its value as a manure, and its hygienic disposal. 5000 w. Surveyor—June 7, 1912. No. 33779 A.

The Joint Scheme of Sewerage of Thornton-le-Fylde, Bispham-with-Norbreck, and Carleton. Arthur Hindle. From a paper read before the Roy. San. Inst. Describes the outfall works, ejectors, air-compressing station, etc. 2500 w. Surveyor—May 31, 1912. No. 33667 A.

The Sewage Disposal at Pelham. Illustrated description of works in a residential district requiring heavy reinforcement. 1600 w. Eng Rec—June 22, 1912. No. 33882.

Sewers

Combined Flood-Wall and Intercepting Sewer. Describes a structure at Grand Rapids, Mich., showing how one structure serves a double purpose. 2200 w. Eng Rec—June 22, 1912. No. 33881.

St. Paul's Sand Rock Sewers. C. H. Harold. Illustrates and describes construction details of tunnels and drop shafts cut out of sand rock thirty feet or more below the street surface. 1000 w. Munic Jour—June 6, 1912. No. 33485.

ROADS AND PAVEMENTS

Bitumens

A Review of the Use of Bituminous Materials in the Construction and Maintenance of Highways During 1911. Prof. Arthur H. Blanchard. Read before the Am. Assn. for the Adv. of Science. Describes work accomplished during the past year. 4500 w. Engng & Con—May 29, 1912. No. 33306.

Brick

Strain Measurements of Brick Pavements. James E. Howard. Reports investigations to determine the relation of street-car tracks to pavements, and the effect of variations in temperature. 2000 w. Eng News—June 20, 1912. No. 33859.

The Life of Brick Pavements. Gives results of an inquiry sent to some 75 cities in the United States. 5000 w. Engng & Con—June 19, 1912. No. 33822.

Concrete

Portland Cement Concrete Roads. From a paper by Logan Waller Page before the Am. Assn. of Portland Cement Mfrs. Gives information on present practice in the construction of concrete pavements. 2500 w. Engng & Con—June 12, 1912. No. 33701.

The Concrete Roads of Wayne County, Michigan. George A. Dingman. Describes methods of construction and maintenance. 3000 w. Engng & Con—June 19, 1912. No. 33821.

Convict Labor

Highway Construction in the State of Washington by Convict Labor. Frank A.

Kittredge. An illustrated account of results of convict labor. The work was difficult and the success remarkable. 4500 w. Engng & Con—June 26, 1912. No. 34103.

Costs

See Accounting, under INDUSTRIAL ECONOMY.

Highways

Highway Maintenance. Robert D. Kneale. Considers causes of road disintegration, and methods of counteracting them. 2000 w. Jour Assn of Engng Socs—May, 1912. No. 33816 C.

Light Traffic

Light Traffic Pavements for Boulevards, Residence Streets and Highways. Linn White, and A. C. Schroder. Also discussion. Deals particularly with work in Chicago. 13500 w. Jour W Soc of Engrs—May, 1912. No. 33686 D.

New Jersey

Public Roads, New Jersey, U. S. A. E. A. James. Illustrates and describes types of pavement adopted, giving costs. 1200 w. Can Engr—June 20, 1912. No. 33909.

Oiled Macadam

The Mud Nuisance on Oiled Macadam Roads. A letter from K. F. Postle, giving information concerning California roads. 2500 w. Eng News—June 6, 1912. No. 33493.

Street Crowns

Crown of Paved Streets. S. Whinery. States the purpose of a street crown and suggests forming a slight ridge at the center to improve the transverse slopes. 1400 w. Eng News—June 6, 1912. No. 33492.

Surfaces

Motor Car Traffic and Main Road Crusts. Discusses the value of surface layers. 1800 w. Surveyor—May 24, 1912. No. 33451 A.

WATER SUPPLY

Check Valves

Special Check Valves on City and Factory Water Supply Interconnections, Auburn, N. Y. J. Walter Ackerman. Describes the valves and the conditions that led to their installation. 1000 w. Eng News—June 13, 1912. No. 33710.

Dams

Recent Studies of Ice Pressures and Their Consideration in Masonry Dam Design. Information from recent discussions and papers bearing on this subject. 5500 w. Engng & Con—June 26, 1912. No. 34100.

Backwater Effects of Exposed and Submerged Dams on the Rock Island Rapids of the Upper Mississippi River. Charles W. Durham. Sketches and explanations of results in two well authenticated cases. 1000 w. Engng & Con—May 29, 1912. No. 33302.

The Arrowrock Dam, Boise Irrigation Project, U. S. Reclamation Service. Charles H. Paul. Illustrated description

of the site, construction camp and plant, and outline of the work. A rubble concrete dam. 3500 w. Eng News—June 6, 1912. No. 33488.

The Delta Dam and Storage Reservoir for Supplying Water to the Rome Summit Level, New York State Barge Canal. Emile Low. Map and illustrated description of this masonry dam and reservoir and the methods of construction. 8000 w. Engng & Con—June 19, 1912. No. 33818.

The Great Dam at Lake Coquittam. Illustrated description of a dam designed to store 175,600 acre feet. 2500 w. Can Elec News—June, 1912. No. 33651 C.

The Hebgen Dam. Harry H. Cochrane. Illustrated description of an important earth-fill dam near Yellowstone Park, which will produce one of the largest artificial reservoir in the United States. 1500 w. Jour Assn of Engng Socs—May, 1912. No. 33817 C.

Timiskaming Dam Construction. Abstract from the second annual report of C. R. Coutée, describing this work. Ills. 4000 w. Can Engr—June 20, 1912. No. 33904.

Filtration

The Air System of the Queen Lane Preliminary Filters. Charles B. Buerger. Illustrated description of the apparatus at the filter plant in Philadelphia. 1000 w. Eng Rec—June 22, 1912. No. 33877.

Filtration Results at Albany. Brief description with report of results. 2000 w. Eng Rec—June 22, 1912. No. 33884.

The Louisville Water Filtration Plant. Illustrated description of the reconstruction of a 36,000,000-gal. plant by subdividing the steel tanks and installing a ridge and valley under drain system. 2500 w. Eng Rec—June 1, 1912. No. 33289.

Forecasting

Predicting Water Supply for the Farmer. J. Cecil Alter. Illustrated account of surveys made of snow in the mountains to forecast the summer flow of streams. 1500 w. Sci Am Sup—June 29, 1912. No. 33991.

Ice Troubles

Ice Troubles at Buffalo. Henry L. Lyon. An account of conditions and the troubles which it is believed have been controlled. 1200 w. Eng Rec—June 15, 1912. No. 33724.

Irrigation

Combined Irrigation and Hydro-Electric Power Schemes. E. Kilburn Scott. Information concerning the success of such enterprises and their possibilities. 1500 w. Elec Rev, Lond—May 31, 1912. No. 33659 A.

The Williston and the Buford-Trenton Electric Irrigation Projects. C. P. Eldred. Illustrated description of the transmission of energy directly from lignite coal mines for irrigation pumping. 2500 w. Elec Wld—June 15, 1912. No. 33736.

Egypt and the Soudan. Editorial review of Lord Kitchener's last report, especially the part dealing with irrigation. 2000 w. Engng—June 7, 1912. No. 33789 A.

Leakage

Making a Leakage Survey. F. H. Shaw. Describes methods used and states cost. Ills. 1500 w. Munic Jour—June 20, 1912. No. 33901.

London

Future Supplies of Water for London. Information from the report of the Works and Stores Committee of the Metropolitan Water Board on a scheme for increasing the supply of water north of the Thames. 1500 w. Engr, Lond—May 24, 1912. No. 33467 A.

Mine-Water

Treatment of Mine-Water from the Ashio Copper Mine. Joseph W. Richards. Explains conditions at this mine in Japan, and describes methods used to purify and clarify the water before it enters the Watarese river. Ills. 800 w. Bul Am Inst of Min Engrs—June, 1912. No. 34053 F.

Minnesota

Water Resources of Minnesota. George A. Ralph. Descriptive review of the extensive resources. Ills. 1500 w. Jour Assn of Engng Socs—May, 1912. No. 33814 C.

Pipe Corrosion

Electrolysis from Stray Electric Currents. Albert F. Ganz. Abstract of paper read before the Am. W.-Wks. Assn. Explains the sources of such currents, their dangers and the damage, and remedial measures. 4000 w. Eng Rec—June 15, 1912. No. 33723.

Pipe Freezing

Methods of Thawing Frozen Service Pipes, and Distributing the Cost Thereof. A topical discussion. 3000 w. Jour N.-Eng W.-Wks Assn—June, 1912. No. 34032 F.

Pipe Obstructions

Detecting Obstructions in Fire Service Mains. Frederick C. Moore. Explains method of testing and recording. 1200 w. Eng Rec—June 8, 1912. No. 33624.

Pollution

Contamination of the Water Supply at Memphis, Tenn., by the April Mississippi Floods. Paul D. Fuqua. Gives a short description of the city water supply, the city's drainage and sewerage, and how the contamination occurred. Ills. 3000 w. Eng News—June 13, 1912. No. 33708.

See also Mine Waters, under *Water Supply*.

Pumping Stations

Centrifugal Pumping Plants for Irrigation and Drainage. H. L. Hutson. Considers plants of moderate capacity used by the irrigation canal companies of Louisiana and Texas for raising water from rivers into their canal system. Dis-

cussion. 10000 w. Jour Assn of Engng Socs—May, 1912. No. 33813 C.

Electric Irrigation Pumping in Southern California. An account of operating experiences of pumping plants in the Pomona district. Ills. 4500 w. Elec Wld—June 8, 1912. No. 33611.

Central Station Power for Municipal Pumping. Presents advantages and gives data on a large number of plants. Ills. 5000 w. Elec Rev & W Elect'n—June 1, 1912. No. 33384.

Grand Rapids Municipal Power and Pumping Plants. Samuel A. Freshney. Illustrated detailed description of the work of enlarging pumping and boiler plants and constructing a new building without interrupting operation. 3000 w. Munic Jour—June 20, 1912. No. 33900.

Pumping Station No. 5 of the Düsseldorf Water Works (Das Pumpwerk V des Wasserwerks der Stadt Düsseldorf). A. Lenze. Description of plant, the most noteworthy of series of stations obtaining water from the underground flow of the Rhine. Ills. 6000 w. Zeitschr d Ver deutscher Ing—May 4, 1912. No. 33570 D.

Purification

Water Purification at Minneapolis. J. Arthur Jansen. The process combines sedimentation, mechanical filtration with lime and sulphate of alumina as reagents, and hypochlorite of lime as a disinfectant. 5000 w. Eng News—June 27, 1912. No. 34112.

The New Municipal Water Purification Plant at Niagara Falls, New York. Illustrated description of a plant of the rapid mechanical type with provision for sterilization with hypochlorite of lime if found necessary. 3000 w. Eng Rec—June 1, 1912. No. 33292.

The Plant for Sterilizing the Croton Water Supply of New York City. An account of the chlorinating plant under construction at Dunwoodie, explaining how the chemical solution will be prepared and introduced into the aqueducts carrying a maximum flow of 380,000,000 gals. daily. 2000 w. Eng Rec—June 1, 1912. No. 33290.

New Methods for the Purification of City Water Supplies (Neue Methoden der Trinkwasserreinigung zur Wasserversorgung der Städte). Alexander Swetz. A review of some of the recent methods, as discussed at the International Hygiene Congress in Dresden. Ills. Serial. 1st part. 4200 w. Zeit d Oest Ing u Arch Ver—May 17, 1912. No. 33564 D.

Reservoirs

The Economy of Circular Reinforced Concrete Reservoir Construction. Alexander Potter. Ills. 1500 w. Jour N-Eng W-Wks Assn—June, 1912. No. 34030 F.

Residence Supply

Modern Systems of Water Supply. Illustrates and describes machines and ap-

pliances used in furnishing conveniences in country residences, their construction, operation, etc. 2000 w. Met Work—May 31, 1912. Serial. 1st part. No. 33336.

Sanitation

Sanitary Survey of the Ottawa River. From a report by James O. Meadows to the Board of Health of the Province of Quebec. Reports a study of the river made to determine its use as a source of water supply. 2500 w. Can Engr—June 13, 1912. No. 33729.

Settling Basins

The Value of a Continuous Settling Basin. Alexander Potter. Abstract of a paper before the Am. W-Wks. Assn. Describes a new settling basin at Muskogee, Okla. Ills. 1500 w. Eng Rec—June 15, 1912. No. 33722.

Semi-Arid

Some Water Supply Problems Encountered in the Semi-Arid Regions of the United States. Clarence Goldsmith. An account of difficulties, sources of supply, and related matters. Discussion. 5500 w. Jour N-Eng W-Wks Assn—June, 1912. No. 34031 F.

Softening.

Water-Softening Plant for 10,000 Gallons per Hour. Describes a plant at York, Eng., having many points of interest from the point of view of the exceptionally hard nature of the water, and the stringent guarantees to be fulfilled. Ills. 2500 w. Engng—May 17, 1912. No. 33273 A.

The Water Softening Plant at Owensboro, Ky. Philip Burgess. Plan and sections showing the arrangement, with description of method of treating deep well water chemically before sedimentation. 3300 w. Eng Rec—June 1, 1912. No. 33291.

Submerged Mains

Construction Methods Employed in Laying Submerged Water Mains Across Three Rivers in Georgia and Mississippi. From a paper by M. L. Worrell, before the Am. W-Wks. Assn. Illustrated description of methods adopted. 2500 w. Engng & Con—June 19, 1912. No. 33823.

Tanks

An Unusual Type of Elevated Concrete Tank. Describes the Construction of a 100,000-gal. reinforced concrete tank having a double dome bottom and resting on columns 75 feet high. 2000 w. Eng Rec—June 1, 1912. No. 33294.

Toronto

Report on Toronto Water. Abstract of a report of consulting engineers appointed to examine the supply, and advise concerning its improvement. Ills. 8000 w. Can Engr—May 30, 1912. No. 33333.

Water-Power

Water-Power Development in the South. J. A. Switzer. Illustrated description of hydro-electric work in the southern Ap-

palachian region. 3000 w. Cassier's Mag—June, 1912. Serial. 1st part. No. 33848 B.

The Design and Methods Employed in Constructing the Cooke Water-Power Plant on the Au Sable River in Michigan—Concrete Mixtures Used—Tests of Turbines—Camp Sanitation. 4500 w. Engng & Con—June 5, 1912. No. 33482.

See also Power Resources, under MECHANICAL ENGINEERING, Power and Transmission.

Water Towers

The General Design and Specifications for the Elevated Structural Steel Water Tower and Tank of 100,000 gals. Capacity, Hamilton, Ill. Outline and detail drawings, with specifications. 2000 w. Engng & Con—June 19, 1912. No. 33824.

Water-Works

Cheltenham Waterworks. J. S. Pickering. Read before the Inst. of W-Wks. Engrs. Plan and illustrated description. 2200 w. Surveyor—June 7, 1912. No. 33780 A.

The Design and Construction of the Municipal Water-Works System at Mountain Home, Idaho, with Some Costs. Edmund M. Blake. Describes the town and conditions and the system, giving cost. Ills. 3000 w. Engng & Con—May 29, 1912. No. 33307.

The Gloucester Water-Works, Witcombe Reservoirs. R. Read. Describes the works and briefly reviews their history. 2000 w. Surveyor—June 14, 1912. No. 33931 A.

The Storage Yard and Shops of the Detroit Water-Works Commission. Describes method of handling and recording supplies for a large system, and the installation of a meter testing shop for insuring accurate work in the water department. 2000 w. Eng Rec—June 1, 1912. No. 33293.

Water-Works Management

The Principles of Efficiency Applied to Water-Works. Harrington Emerson. Abstract of paper read before the Am. W-Wks. Assn. States and discusses the principles as applied to water-works. 2000 w. Eng Rec—June 15, 1912. No. 33725.

Wells

The Water Supply of Joliet, Ill. Methods of Overcoming Difficulties Encountered in Sinking New Deep Rock Wells. H. A. Stevens. Read before the Ill. Water Supply Assn. 3000 w. Engng & Con—June 26, 1912. No. 34104.

Worcester, Mass.

How the Water Emergency at Worcester, Mass., Was Handled in the Summer of 1911, Together with a Brief Description of Worcester's Sources of Water Supply. Frank C. Kimball. Ills. 9000 w. Jour N-Eng W-Wks Assn — June, 1912. No. 34029 F.

WATERWAYS AND HARBORS

Breakwaters

The More Recent Types of Breakwater Construction and the Unit Cost of Several of Importance in the United States. Abstract of a paper by J. F. Hasskarl, before the Int. Cong. of Nav., outlining practice on the seacoast and on the Great Lakes. 2500 w. Engng & Con—June 26, 1912. No. 34101.

Method of Constructing a Breakwater at Naples, Italy, Using Concrete Hollow Blocks Made of Puzzuolana-Portland Cement. Illustrated description of the construction as given by I. Inglese in a report to the Int. Cong. of Nav. 3500 w. Engng & Con—June 12, 1912. No. 33699.

Canals

The Navy's Interest in the Cape Cod Canal. J. W. Miller. Explains the general features of this canal and their relation to coastwise commerce; discusses its effect upon naval service; its military importance; and illustrates its bridges and other features. Map. 2000 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33826 H.

Blowout of a Canal Retaining Wall at Ansonia, Conn. An illustrated description of the failure on May 28, 1912, and the circumstances attending it. 1500 w. Eng News—June 20, 1912. No. 33863.

The Break in the Power Canal Wall at Ansonia. J. R. Coe. Illustrated description of a blow-out which occurred on May 28, under a new canal-bank retaining wall at Ansonia, Conn. 1200 w. Eng Rec—June 15, 1912. No. 33720.

Present Construction of Navigable Canals in France (Le attuali costruzioni delle vie navigabili in Francia). P. De Sanctis. Review of the paper submitted by M. J. Bourgougnon to the Twelfth International Navigation Congress. Ills. 5400 w. Ann della Soc d Ing e d Arch Ital—May 16, 1912. No. 34011 E.

Channels

Commercial Results from the Improvement of a Tidal Creek for Navigation. R. R. Raymond. Map and description of improvement of the Murderkill River, Delaware, as a type of the problems presented and results obtained. 2000 w. Eng News—May 30, 1912. No. 33324.

Livingston Channel; Detroit River. E. T. Lednum. A general description of the submarine work to give greater depth and width for the modern large vessels. Ills. 4000 w. Eng News—May 30, 1912. No. 33323.

Dock Machinery

Cargo-Loading and Discharging Appliances at Immingham Docks. Illustrated description of the mechanical equipment of these new docks on the Humber River. Plate. 2500 w. Engng—June 14, 1912. Serial. 1st part. No. 33941 A.

The New Loading and Granary Constructions of the Holland-America Line

in Rotterdam (Die neuen Verlade- und Speichereinrichtungen der Holland-Amerika-Linie in Rotterdam). Description of dock machinery and grain elevator, chute, and storage house. Ills. 4800 w. Zeitschr d Ver deutscher Ing—June 1, 1912. No. 33580 D.

Docks

A Reinforced Concrete Oil Loading Dock. Illustrated description of a structure recently built at Port Arthur, Texas. 1200 w. Eng Rec—June 8, 1912. No. 33626.

New Graving Dock on the Tyne. Illustrated detailed description of the new graving dock at South Shields, and other improvements. 3000 w. Engr, Lond—May 31, 1912. No. 33677 A.

The Immingham Dock and Sidings. Illustrated detailed description of a large deep-water dock on the Humber estuary, recently opened for traffic. 1500 w. Engr, Lond—May 17, 1912. Serial. 1st part. No. 33777 A.

Dry Docks

An Improvement in Floating Dry Docks. A. C. Cunningham. Describes an improved type of self-docking steel floating dock. 1000 w. Pro U S Naval Inst—June, 1912. No. 33975 E.

Calculations for Floating Docks (Schwimmdockberechnung). D. Muth. Mathematical discussion on the design of floating docks, with tables. 3000 w. Schiffbau—May 8, 1912. No. 33541 D.

Drainage

The Maintenance of Open Drainage Ditches. A. P. Smith. From a paper before the Iowa Engng Soc. Considers some maintenance problems and their solutions. 2000 w. Engng & Con—June 12, 1912. No. 33704.

The Little River Drainage Works in Missouri. William A. O'Brien. Map and brief description of reclamation work. 2000 w. Eng Rec—June 22, 1912. No. 33883.

Floods

1912 Flood on the Lower Mississippi. A. L. Dabney. On the extent of the recent floods, the damage done to the levees and levee districts, with comments on the repairs and future protection. Ills. 3500 w. Eng News—June 13, 1912. No. 33709.

See also Pollution, under *Water Supply*.

Frankfort

The New Eastern Port in Frankfort (Der Neue Osthafen in Frankfurt a. M.). J. Elink Schuurman. Details of railway yards, port, and harbor machinery. Ills. 3500 w. Zeitschr d Ver deutscher Ing—May 25, 1912. No. 33575 D.

Harbors

Harbor of Cleveland, O. From an address by Col. John Millis before the Cleveland Chamber of Commerce, showing wherein it excels other lake harbors, and wherein it has failed to take advantage

of its opportunities. 2000 w. Marine Rev—June, 1912. No. 33638 C.

The New Valparaíso Port. Information concerning the new works now being placed under contract, and the modifications found necessary. 1200 w. Engr, Lond—May 24, 1912. No. 33465 A.

The Completion of Colombo Harbor, Ceylon. An account of the completion of extensive works covering over 37 years of continuous work. Ills. 3000 w. Engng—May 31, 1912. No. 33674 A.

Inland Waterways

Inland Water-Borne Commerce in the United States. John Ruddle. Discusses conditions and the probability that improvements will not become self-supporting for some time; how the improvements can be most efficiently and economically carried out; principles of operation, etc. 8500 w. Int Marine Engng—June, 1912. No. 33439 C.

Locks

Reinforced Concrete Lock Construction by the Hungarian State Water Survey. Describes a lock on the Koros River, at Bokeny. 1800 w. Engng & Con—June 12, 1912. No. 33698.

Two Examples of Reinforced Concrete Canal Lock Construction in Russia. Illustrations with brief descriptions. 1000 w. Engng & Con—June 5, 1912. No. 33478.

Reconstruction of Boulter's Lock. Illustrated account of the rebuilding of this lock on the Thames. 2000 w. Engr, Lond—June 7, 1912. No. 33792 A.

Disappearing Swinging Gates (Waairendeur te Scheveningen). F. C. J. van der Steen. Describes lock-gates working automatically; closed by rising tides and opened by receding tides. Ills. 3500 w. De Ingenieur—May 4, 1912. No. 33582 D.

Panama Canal

Glimpses of the Panama Canal. E. D. Gilman. Brief outline of the work and the conditions that have made it successful. Ills. 4000 w. Wis Engr—May, 1912. No. 33649 C.

Panama Canal Tolls. Charles H. Stockton. Discusses important features in connection with the coastwise trade of the United States, via the Panama Canal. 2000 w. Pro U S Nav Inst—June, 1912. No. 33972 E.

The Panama Canal (Le Canal de Panama). A. Dumas. A brief history of the undertaking, followed by a general description of the route and plans, and finally an outline of the present stage in construction. Ills. and plates. Serial. 1st part. 25000 w. Génie Civil—May 25, 1912. No. 34005 D.

The Panama Canal (Le Canal de Panama). M. A. Dumas. Reviews the history of the undertaking, the present condition of the work, and the economic consequences. Ills. and plates. 150 pages. Ann d Ponts et Chaussées—March-April, 1912. No. 33587 E + F.

See also Panama, under RAILWAY ENGINEERING, *New Projects*.

River Improvement

The Improvement of the Neponset River in Massachusetts. An account of improvements to remedy unsanitary conditions caused by the recent flooding of the river. 1400 w. Eng News—June 27, 1912. No. 34111.

The Improvement of the Neponset River in Massachusetts. Edmund M. Blake. Describes improvements to overcome unsanitary conditions. 1500 w. Eng Rec—June 1, 1912. No. 33298.

Submarine Excavation

A Review of Methods Employed for Removing Subaqueous Rock. Abbreviated review of methods given by Michael Koch in a report to the Int. Cong. of Nav. 3000 w. Engng & Con—May 29, 1912. No. 33305.

Methods and Costs of Operating Loebnitz Rock Breakers and Drill Boats on

the Panama Canal. Reprint of data given by S. B. Williamson in a report to the Int. Cong. of Nav. 1500 w. Engng & Con—May 29, 1912. No. 33304.

Methods and Costs of Rock Excavation in the Harbors of Aviales, San Esteban de Pravia, and Port de Bilbao, Spain. Gives an account of the use of a Lobnitz rock breaker in three Spanish harbors, as described by Ramon Hernandez in a paper before the Int. Cong. of Navigation. 4000 w. Engng & Con—June 19, 1912. No. 33820.

Terminals

Mechanical Equipment of Sea Port and Inland Waterway Terminals. H. McL. Harding. Considers important freight movement that should be performed by machinery, and provided at terminals. Ills. 3000 w. Int Marine Engng—June, 1912. No. 33438 C.

See also same heading, under ELECTRICAL ENGINEERING, *Power Applications*.

ELECTRICAL ENGINEERING

COMMUNICATION

Great Britain Systems

Telegraphy and Telephony. W. A. J. O'Meara. Abstract of a lecture delivered before the Yorkshire Local Section of the I. E. E. Describes apparatus and lines in Great Britain particularly. 3500 w. Elect'n, Lond—May 31, 1912. No. 33662 A.

Oscillograph

Some Points in the Use and the Theory of the Oscillograph. J. K. A. Wertheim Salomonson. Discusses the design of transformer and oscillograph (particularly in reference to damping) when they are used in conjunction with a microphone for the production of vocal curves. 3000 w. Elect'n, Lond—June 7, 1912. No. 33773 A.

See also Commutation, under *Dynamos and Motors*.

Radiotelegraphy

The Determination of Wave-Length in Wireless Telegraphy (Mesure des Longueurs d'Onde en Télégraphie sans Fil). R. Jouaust. Mathematical discussion. Diagrams. 9500 w. Bull Soc Int d'Électriciens—May, 1912. No. 33590 F.

See also Prospecting, under MINING AND METALLURGY, MINING.

Telegraphy

Railway Telegraph Superintendents. A report of the New York meeting, with abstracts of papers. 5500 w. Ry Age Gaz—June 14, 1912. No. 33712.

Military Telegraph Lines Using the Polarized Sounder as Receiving Instrument. George R. Guild. Describes some of the important phases of single impulse induced current circuits, and indicates the instruments which the writer has

found best adapted to these circuits. Ills. 5500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34067 F.

Telephone Cables

Pupin or Krarup Cables (Pupin-oder Krarup-Kabel)? E. F. Petritsch. Comparison of the two systems of telephony with reference to lines of either system now installed. Ills. Serial. 1st part. 2800 w. Elektrotech u Maschinenbau—May 19, 1912. No. 33537 D.

Telephony

The Vibrations of Telephone Diaphragms. Charles F. Meyer and J. B. Whitehead. An account of work undertaken to obtain more accurate information concerning the way the diaphragms vibrate. Ills. 5500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34073 F.

Telephone Party-Lines (Gesplitste telefoonansluitingen). C. L. van der Bilt. Description of the operation of the ordinary party-line system. Ills. 9500 w. De Ingenieur—June 1, 1912. No. 33586 D.

Telephotography

The Transmission of Photographs Over Telephone Wires. Illustrates and describes briefly recent improvements in Dr. Korn's method and results. 800 w. Sci Am—June 1, 1912. No. 33284.

DYNAMOS AND MOTORS

A. C. Motors

The Circle Diagram of the Three-Phase Series Commutators (Das Kreisdiagramm des Drehstromkollektor-Serienmotors). L. Dreyfus and F. Hillebrand. Mathematical discussion on the circle diagram under several conditions. Diagrams. Serial. 1st part. 6000 w. Elektrotech u Maschinenbau—May 12, 1912. No. 33535 D.

Alternators

The Transient Reactions of Alternators. William A. Durgin and R. H. Whitehead. Investigates the influence of a characteristic of alternators known as the transient impedance. 4000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34065 F.

Commutation

An Indicating Coil for Applying the Oscillograph to the Study of Commutation. David Robertson. Abstract from the Jour. of the I. E. E. Explains a way in which the oscillograph can be applied to show the internal currents in an armature without cutting one of the main coils. 1000 w. Elect'n, Lond—June 7, 1912. No. 33774 A.

D. C. Machinery

Substation Apparatus for the Generation of Direct Current. H. F. T. Erben. Discusses recent improvements in the design and construction of d. c. substation machinery. Ills. 4500 w. Gen Elec Rev—June, 1912. No. 33377 C.

Generators

Notes on the Design of Water-Wheel Driven Generators. H. G. Reist. Illustrates and describes salient features. 1200 w. Gen Elec Rev—June, 1912. No. 33378 C.

Development of a Successful Direct-Current 2000-KW. Unipolar Generator. B. G. Lammne. A record of engineering experiences, and difficulties overcome, in the development of a large unipolar machine. Ills. 9000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34070 F.

The Squirrel-Cage Induction Generator. Describes its attributes and discusses the correct economic field for such machines. Ills. 5500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34074 F.

Induction Motors

The Design of Induction Motor Shafts to Resist Deflection. Bradley T. McCormick. Gives formulae and illustrates their application. Ills. 1000 w. Can Engr—June 20, 1912. No. 33907.

Phase Advancers

On Phase Advancers for Non-Synchronous Machines. Gisbert Kapp. From *Jour. Inst. of Elec. Engrs*. Refers to Leblanc's method of attaining this end and considers the theory of this method. Describes a vibrator devised by the author for injecting this E. M. F. 4500 w. Elect'n, Lond—May 17, 1912. Serial. 1st part. No. 33264 A.

Starting Currents

Motor Starting Currents as Affecting Large Transmission Systems. P. M. Lincoln. An investigation of starting conditions in mills taking power from company lines. 3000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34068 F.

Turbo-Generators

Operating Characteristics of Large Generators. A. B. Field. Considers the

trend of modern practice in respect to some requirements of station engineers. 4500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34069 F.

ELECTRO-CHEMISTRY**Cells**

Dry Cells—Their Uses and Testing. Tentative report of the American Electrochemical Society Committee on dry cell tests. 5500 w. Met & Chem Engng—June, 1912. No. 33417 C.

Corrosion

Electrolytic Corrosion of Iron by Direct Current in Street Soil. Albert F. Ganz. Describes experiments designed to determine the relative rates of corrosion of various kinds of iron in two kinds of street soil, when subjected to such low current densities as are found on underground structures. 3500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34071 F.

Iron Corrosion Investigations. Oliver P. Watts. Read before the Am. Elec.-Chem. Soc. A study of the protective action of arsenic, giving results of experiments. 1800 w. Chem Engr—June, 1912. No. 33961 C.

The Corrosion of Iron and the Protection of Structural Iron-Work. L. Archbutt. Read to the Derby Soc. of Engrs. Discusses causes and protective measures. 4500 w. Engng—June 7, 1912. Serial. 1st part. No. 33791 A.

Painting Engine and Fireroom Bilges. Henry Williams. Discusses deterioration due to corrosion and the necessity for protection, considering the methods adopted and their advantages. 3500 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33829 H.

The Corrosion of Bronze Propeller-Blades. William Ramsay. Illustrated study of the varieties of blade corrosion. 2500 w. Engng—May 24, 1912. No. 33461 A.

See also Electrolysis, under CIVIL ENGINEERING, *Construction*; and Pipe Corrosion, under CIVIL ENGINEERING, *Water Supply*.

Electric Furnaces

Thirty Years' Progress in the Electric Furnace. F. A. J. Fitzgerald. A review of development. 3500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34063 F.

The Electric Furnace (Der elektrische Hochofen). W. Rodenhäuser. A general review of the history of electric furnaces, with particular reference to the Trollhättan plant and its work. Ills. 6000 w. Elek Kraft u Bahnen—May 24, 1912. No. 33533 D.

See also same heading, under MINING AND METALLURGY, *Gold and Silver*.

Electroplating

A New Method of Electrodepositing Nickel and Iron Together. Describes a method recently patented by August Leuchter. 800 w. Brass Wld—June, 1912. No. 33839.

The Acid Copper Solution and Method of Making It. Explains the advantages and disadvantages of this solution, and how to use it successfully. 1000 w. Brass Wld—June, 1912. No. 33836.

The Electroplating of Wood. Describes the method. 1200 w. Brass Wld—June, 1912. No. 33837.

Nitrates

The Manufacture of Nitrates from the Atmosphere. Ernest Kilburn Scott. Illustrated review of this metallurgical development of electric power, the processes and installations and subjects related. Short discussion. 13000 w. Jour Soc of Arts—May 17, 1912. No. 33255 A.

Ozone

Increasing Human Efficiency by Ozone. W. H. Radcliffe. Explains the qualities of ozone and how it is made, and the use of electrical discharges in sanitation. Ills. 1800 w. Cassier's Mag—June, 1912. No. 33843 B.

ELECTRO-PHYSICS

Air Strength

The Electric Strength of Air. J. B. Whitehead. Third of a series of papers describing investigations of the physical laws underlying the breakdown of the air under electric stress. Ills. 7500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34061 F.

Alternating Currents

Elementary Notes on Alternating Currents. First of a series of explanatory articles. Ills. 1800 w. Elec Rev & W Elect'n—June 15, 1912. Serial. 1st part. No. 33743.

Alternators in Parallel; Installation and Operation. George E. Edwards. A discussion of the factors to be considered in installing and operating such units to secure satisfactory results. 4500 w. Min & Engng Wld—June 15, 1912. No. 33751.

Alternating-Current Development in America. William Stanley. Describes the condition of the electric lighting industry when the A. C. system was introduced; the causes that made it necessary to devise a new system of distribution, and its growth. Ills. 5000 w. Jour Fr Inst—June, 1912. No. 34025 D.

Conductivity

The Convection and Conduction of Heat in Gases. Irving Langmuir. Gives results supporting the theory of the conductive film. 3000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34072 F.

Dielectrics

The Law of Corona and Dielectric Strength of Air—II. F. W. Peek, Jr. The second paper of a report of extensive investigations of corona formation and loss. Ills. 5500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34076 F.

Electromagnets

Operation of Plunger Electromagnets. Charles R. Underhill. Calls attention to conditions which may introduce serious

errors by applying the Maxwell formula. 1800 w. Elec Wld—June 22, 1912. No. 33887.

Frequency

Frequency. D. B. Rushmore. Discusses the influence of frequency in connection with generators, transformers, transmission lines, lightning, induction motors, synchronous motors, frequency changers, synchronous converters, railroad work, switching phenomena and illumination. 4000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34059 F.

High Frequency Phenomena with Especial Reference to Oscillations and Surges. W. T. Ryan. A practical treatment of high frequency phenomena and explanation of destructive effects on particular occasions. 3000 w. So Elect'n—June, 1912. No. 33405.

Radio-Chemistry

A Discussion of Radio-Chemistry. Harry C. Jones. Discusses radioactive phenomena and the effect of recent advances upon science and the industries. 6500 w. Eng & Min Jour—June 8, 1912. No. 33616.

Reactance

Synchronous and Asynchronous Reactance. J. Rezelman. Deals with the reactance of a single-phase high frequency alternator. Ills. 2000 w. Elect'n, Lond—June 7, 1912. No. 33775 A.

Rectifiers

Theory of the Operation of Mercury Rectifiers. R. P. Jackson. Explains the theory of the mercury rectifier. 3000 w. Elec Jour—June, 1912. No. 34047.

See also same heading, under STREET AND ELECTRIC RAILWAYS.

Resistance

Simplification of Electro-Thermal Calculations; the Watt and Thermal Ohm. Carl Hering. A discussion of units of thermal resistance, pointing out their most rational values and urging general adoption. 3500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34064 F.

Incandescent Lamps as Resistances. T. H. Amrine. Emphasizes their value and gives information regarding the resistance characteristics, ranges of resistance and current carrying capacities available and other information. 1500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34090 F.

GENERATING STATIONS

Accumulators

The New Edison Accumulator (Der neue Edison-Akkumulator). Herr Dierfeld. Description of new cells and a review of their properties. Ills. 2500 w. Glaser's Ann—May 15, 1912. No. 33526 D.

See also Cells, under *Electro-Chemistry*; and Accumulator Traction, under STREET AND ELECTRIC RAILWAYS.

Central Stations

Some Problems in Central Station and Substation Operation. C. W. Stone. Under central station questions are con-

sidered excitation, and means of limiting trouble at times of short circuit; under substations, considers the relative advantages of synchronous converters and motor-generator sets. 4000 w. Gen Elec Rev—June, 1912. No. 33373 C.

Steam Driven Electric Plants (Mit Dampf betriebene elektrische Kraftwerke) Oskar Bühring. Review of the growth and costs of some German power stations within a period of ten years. 3500 w. Elek Kraft u Bahnen—May 4, 1912. No. 33531 D.

Berlin's Power Plants (Ueber Berliner Kraftwerke). H. Hanszel. A review of the electric generating stations in and around Berlin at the end of the year 1911. Ills. Serial. 1st part. 2400 w. Zeit d Oest Ing u Arch Ver—May 31, 1912. No. 33567 D.

Costs

The Cost of Generating Electrical Power in Small Plants. Gives calculations for a typical case. 2200 w. So Elect'n—June, 1912. No. 33406.

Extensions

Extension of the Redondo Stations of the Pacific Light & Power Co. Illustrated account of an addition to the boiler plant and remodeling of condenser circulating-water system. 2500 w. Elec Wld—June 15, 1912. No. 33735.

Hydro-Electric

Recent Hydro-Electric Development, and the Probable Course of Future Progress. David B. Rushmore. Gives statistics showing the possibilities in the United States, and reviews recent progress. Ills. 3000 w. Gen Elec Rev—June, 1912. No. 33370 C.

Development Along Puget Sound. Illustrated description of the hydroelectric system of the Puget Sound Traction, Light & Power Co. on the Snoqualmie, Puyallup, and White rivers. 10500 w. Elec Wld—June 1, 1912. No. 33426.

The Municipal Plant at Seattle. Illustrated description of the 11000-kw. hydroelectric development on Cedar River and auxiliary 1500-kw. water-power station in Seattle. 3500 w. Elec Wld—June 1, 1912. No. 33427.

Developments on Spokane River, Wash. Illustrated description of plants of the Washington Water Power Co., showing the utilization of the hydraulic resources of a single stream. Also editorial. 4000 w. Elec Wld—June 22, 1912. No. 33886.

Great Falls Hydro-Electric Development in South Carolina. George Byrne. Illustrated description of this development and the possibilities of the region surrounding it. 3500 w. Mfrs' Rec—June 13, 1912. No. 33689.

Power Development on East Canada Creek. Plan and illustrated description of a new 4000-h.p. unit to supplement an old 1000-kw. plant. 1500 w. Eng Rec—June 8, 1912. No. 33619.

Power Development on Trent Canal. A. H. Hull and K. R. McKinnon. An account of government dams being utilized for electric power purposes, giving illustrated description of the plant at No. 2. Ills. 6500 w. Can Elec News—June, 1912. No. 33650 C.

The Hydro-Electric Plant of the Simcoe Railway and Power Company. Illustrated description of the largest hydraulic development in the Georgian Bay district, Canada. 2500 w. Can Eng—June 20, 1912. No. 33908.

The Ocoee Hydro-Electric Development. Illustrated description of the new plant of the Eastern Tennessee Power Co. supplying current to Chattanooga, Knoxville and Rome. 2500 w. Eng Rec—June 22, 1912. No. 33876.

The Hydro-Electric Project of the Mississippi River Power Company at Keokuk, Iowa. David Taylor. An illustrated description of a notable development in progress, the construction being done by day labor. 2000 w. Engng & Con—May 29, 1912. Serial. 1st part. No. 33309.

See also Irrigation, under CIVIL ENGINEERING, *Water Supply*.

Loads

A Plan for Increasing the Power Load. H. W. Cope. Read at Seattle convention of the N. E. L. A. Considers some of the problems of the central station and their solutions. 3500 w. Elec Rev & W Elect'n—June 15, 1912. No. 33742.

The Importance of Hiring Powers in Cultivating a Domestic Load. H. H. Holmes. Discusses this means of advancing the use of electricity and some rules that should be observed in dealing with consumers. 2500 w. Elect'n, Lond—June 14, 1912. No. 33920 A.

Power Selling

Selling Power to Large Manufacturers. A. E. Rickards. Discusses some of the problems involved, the advantages, cost, etc. 2000 w. Elec Jour—June, 1912. No. 34036.

Scotland

Power Generation and Distribution in the Clyde Valley Electrical Power Company's Area. David A. Starr. Abstract of a paper before the Scottish Sec. of the I. E. E. Outlines the early history, the equipment and system of distribution and the recent progress. 4000 w. Elect'n, Lond—June 7, 1912. No. 33770 A.

LIGHTING

Arc Lamps

The Long Burning Flame Carbon Arc Lamp. C. E. Stephens. Illustrated detailed description. 1800 w. Elec Jour—June, 1912. No. 34044.

Filaments

Changes in Metallic Filaments During Use. F. J. Brislee. Shows that the high temperatures causes the filaments to become crystalline. 1200 w. Elect'n, Lond—May 31, 1912. No. 33663 A.

Glare

An Analysis of Glare from Paper. M. Luckiesh. A study of the reflection from papers, stating conclusions. 1500 w. Elec Rev & W Elect'n—June 1, 1912. No. 33387.

Illumination

General Aspects of Industrial Lighting. L. B. Marks. Treats of the problem of artificial illumination in industrial plants. Ills. 2500 w. Elec Rev & W Elect'n—June 1, 1912. No. 33385.

Methods of Calculating Illumination. E. B. Rowe. Discusses methods based on light flux. 2500 w. Elec Jour—June, 1912. No. 34034.

What an Automatic Dynamo Lighting System Should Do. Leonard Keblor. Read before the Soc. of Auto. Engrs. Considers the points of importance in determining the necessary qualifications for such a system. 3500 w. Horseless Age—June 5, 1912. No. 33483.

The Illumination of the Home. F. A. Vaughn. Discusses requirements of different parts of the house. Ills. 2500 w. Elec Rev & W Elect'n—June 1, 1912. No. 33386.

The Problems of Interior Illumination. Bassett Jones, Jr. Considers certain phases of the problem of artificial illumination, due to the architectural character. Ills. 6000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34077 F.

The Installation of Industrial Lighting Systems. C. E. Clewell. Considers details of lamp installations. 4000 w. Elec Jour—June, 1912. No. 34033.

Incandescent Lamps

Vacua. W. R. Whitney. Report of observations made in the research laboratory on some phenomena in vacua. 4000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34066 F.

Incandescent Electric Lamps. Glen P. Cowan. Explains methods of manufacture and operating characteristics. 5000 w. Wis Engr—May, 1912. No. 33648 C.

Development in the Tungsten Lamp. Dr. G. P. Scholl. Reviews recent improvements made in these lamps. 1500 w. Elec Jour—June, 1912. No. 34046.

Condensers in Series with Metal Filament Lamps. A. W. Ashton. Describes recent developments in the use of low-voltage metal filament lamps in series with condensers on alternate-current circuits. 5000 w. Inst of Elec Engrs—May, 1912. No. 33447 N.

Metallic Filament Lamp Economies. Discusses the economies possible by use of the latest types of lamps now manufactured. 1200 w. Prac Engr—June 7, 1912. No. 33777 A.

Photometry

Ultra-Violet Radiation from Ordinary Illuminants. M. Luckiesh. Gives interesting details of a photographic study made of the ultra-violet light given by

various illuminants. Ills. 1200 w. Elec Wld—June 15, 1912. No. 33740.

Reflectors

The Choice of Reflectors for Street Lighting. Dr. L. Bloch. Considers the most suitable shape for the reflector to be used with metal filaments for street lighting, showing that the parabolic gives the best results. 1500 w. Elect'n, Lond—May 31, 1912. No. 33661 A.

Street Lighting

Series Tungsten Lamps for Street Lighting. H. A. Hussey. Discusses the requirements of street lighting and the adaptation of series tungsten lamps. 2500 w. Elec Jour—June, 1912. No. 34035.

Street Lighting by Metallic Flame Arc Lamps. W. P. Hurley and C. B. Padon. A typical installation is illustrated and described. 1500 w. Elec Jour—June, 1912. No. 34041.

MEASUREMENT**Alternating Current**

Measurement of Alternating Current of Low Value. M. G. Newman. Explains method and reports tests and results. Ills. 2000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34082 F.

Calibration

Instrument Calibration by Means of the Spark-Gap. Ralph P. Clarkson. Illustrates and describes apparatus devised by the author for calibrating voltmeters and other instruments for use in very high potential work by comparing them with the spark-gap as a standard. 2000 w. Elec Wld—June 15, 1912. No. 33737.

Electrodynamometer

A Tubular Electrodynamometer for Heavy Currents. P. G. Agnew. Gives the theory, construction, and performance of the instrument. Ills. 1500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34081 F.

Frequency Indicator

Resonant Circuit Frequency Indicator. W. H. Pratt and D. R. Price. Describes the device and its working. 1000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34091 F.

Galvanometers

Characteristics and Applications of Vibration Galvanometers. Frank Wenner. Explains their construction and gives information relating to their use. 2500 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34075 F.

Instruments

Hot Wire Instruments. A. W. Pierce and M. E. Tressler. Explains the special field for use of these instruments. 600 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34089 F.

Induction Type Indicating Instruments. Paul MacGahan. Discusses the principles of operation, accuracy, theory and performance. Ills. 3000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34085 F.

Electrical Transmission of Electrical Measurements. O. J. Bliss. Describes an arrangement of instruments for transmitting and reproducing at a distance a direct electrical measurement, the medium of transmission being a telephone line. 1000 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34079 F.

Lamp Tests

Electrical Measurements with Special Reference to Lamp Testing. Evan J. Edwards. Describes methods used in a photometric and lamp testing laboratory. 1500 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34083 F.

Meters

A New Moving-Coil Measuring Instrument for Direct and Alternating Current. Herr Gossen. Abstract trans. from *Elektrotechnische Zeit.* Descriptive. 1200 w. *Elect'n*, Lond—June 7, 1912. No. 33772 A.

Metering Large Direct-Current Installations. F. V. Magalhaes. A summary of methods now used, with suggestions. 1200 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34080 F.

Metering on Three-Phase Systems. L. T. Robinson. Detailed discussion of a number of arrangements of transformers and meters. 3000 w. *Gen Elec Rev*—June, 1912. No. 33374 C.

Meter Testing

Wheatstone Bridge—Rotating Standard Method of Testing Large Capacity Watt-Hour Meters. C. H. Ingalls and J. W. Cowles. Describes the method and gives results of tests made thereby. 1000 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34092 F.

Switchboard Connections for Testing Meters. G. C. Cassard. Discusses the testing of ammeters by the portable shunt and millivoltmeter method. 1800 w. *Power*—June 11, 1912. No. 33632.

Motor Tests

Instrument Testing Methods and Equipment for Central Stations. E. P. Peck. A discussion of motor tests. 2000 w. *So Elect'n*—June, 1912. No. 33403.

Power-Factor

The Power-Factor of Low-Speed Polyphase Motors. H. M. Hobart. Gives data useful in determining the suitability of synchronous and induction motors for low-speed drives. 1500 w. *Gen Elec Rev*—June, 1912. No. 33381 C.

Rate Computers

A Mechanical Computer for Electric Energy Rates. W. H. Edmondson. Describes a device in the form of a slide-rule. 600 w. *Elec Wld*—June 22, 1912. No. 33888.

Stray Currents

Measuring Stray Currents in Underground Pipes. Carl Hering. Describes methods devised by the writer and used with success in a practical case. 5000 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34078 F.

Temperatures

Temperatures and the Properties of Matter. E. F. Northrup. Reviews investigations in this field, and discusses the relation between temperatures and the facts known experimentally. 5000 w. *Met & Chem Engng*—June, 1912. No. 33414 C.

Units

Tests of Hydro-Electric Generating Units. A. J. Soper and K. R. McKinnon. Directs attention to the value of operating tests on both generators and turbines, giving a detailed account of the most approved testing methods. Ills. 8500 w. *Can Elec News*—June, 1912. No. 33652 C.

Voltage

Measurements of Voltage and Current Over a Long Artificial Power-Transmission Line at 25 and 60 Cycles per Second. A. E. Kennelly and F. W. Lieberknecht. Describes in detail a series of measurements over a line installed at Harvard University. 5000 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34060 F.

Measurements of Maximum Values in High Voltage Testing. C. H. Sharp and F. M. Farmer. Describes methods aiming at improved accuracy in testing. Ills. 1600 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34088 F.

Wattmeters

Compensating Wattmeters. A. L. Ellis. Explains the characteristics of such instruments, the tests for errors, giving information related to these meters. 2500 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34086 F.

The Behavior of Direct-Current Watt-Hour Meters More Especially in Relation to Traction Loads, with Notes on Erection and Testing. S. W. Melsom and W. H. Eastland. Describes tests of various types under working conditions, and gives recommendations regarding the setting up and testing of meters. Ills. 4500 w. *Inst of Elec Engrs*—May, 1912. No. 33263 N.

The Testing of Large Watt-Hour Meters on Fluctuating Loads. F. A. Laws and C. H. Ingalls. Illustrates and describes an ingenious arrangement of apparatus for shunting a portable standard watt-hour meter of 40 amp rating, so as to carry a total measured direct current of 2,000 amp. 1000 w. *Elec Wld*—June 15, 1912. No. 33738.

A New Form of Candles-per-Watt Meter for Incandescent Electric Lamps. Herbert E. Ives. Gives a parallel description of the candle-power photometer as formerly used and of an ideal specific output meter, showing the requirements. Ills. 3000 w. *Elec Wld*—June 8, 1912. No. 33613.

Improper Watthour-Meter Connections. C. A. Howell. Shows the effect of improper connection on meter. 500 w. *Elec Wld*—June 15, 1912. No. 33739.

POWER APPLICATIONS

Pumping Stations

See same heading, under CIVIL ENGINEERING, *Water Supply*.

Terminals

Electrification of Railway Terminals. W. F. M. Goss. Abstract of an address before the City Club of Chicago. An outline of the investigation being made at Chicago and discussion of the proposed change of power. 3000 w. *Ry Age Gaz*—June 14, 1912. No. 33713.

Electric Power in Railway and Marine Terminals. R. H. Rogers. An account of what Seattle is doing to prepare itself for trade expected at the opening of the Panama Canal. Ills. 2000 w. *Gen Elec Rev*—June, 1912. No. 33383 C.

TRANSMISSION

Cables

See Factories, under MECHANICAL ENGINEERING, *Machine Works and Foundries*.

Direct Current

The Transmission of Electrical Energy by Direct Current on the Series System. J. S. Highfield. Abstract of paper before the Glasgow meeting of the I. E. E. Describes a pioneer installation and discusses circumstances which render the adoption of the series system preferable. 4500 w. *Elect'n, Lond*—June 14, 1912. No. 33919 A.

Fault Location

The Location of Faults in Underground Cables (Sur la Localisation des Défauts dans les Cables Souterrains). M. E. Masson. Discussion of the several methods now in vogue. Diagrams. 7500 w. *Bull Soc Int d'Électriciens*—May, 1912. No. 33589 F.

High Tension

Birds and High Tension Lines. William Manktelow. Discusses dangers to bird life and troubles to the system due to contact. 1000 w. *Elec Rev, Lond*—June 7, 1912. No. 33769 A.

A 100,000-Volt Transmission on the Roof of the Continent. Illustrates and describes the operating methods of the Central Colorado Power Co.'s system. 3000 w. *Elec Wld*—June 1, 1912. No. 33430.

Western Transmission Systems. Maps and a brief review of Western high tension system, giving the important features pertaining to each, with comparative data on all high tension systems of the world. 3000 w. *Elec Wld*—June 1, 1912. No. 33428.

World's Largest Transmission System. An outline of the operating system and service conditions of the Pacific Gas & Electric Co. Ills. 3500 w. *Elec Wld*—June 1, 1912. No. 33429.

Notes on Control and Operation of High Voltage Transmission Systems. Charles P. Steinmetz. Explains dangers of switching between transformers and line, and how they may be removed. 1700

w. *Gen Elec Rev*—June, 1912. No. 33372 C.

Insulators

The Line Insulator in Modern High Voltage Transmission Systems. F. W. Peck, Jr. Points out some of the limiting electrical characteristics of the series suspension insulator used on high voltage lines. 1500 w. *Gen Elec Rev*—June, 1912. No. 33380 C.

Line Construction

See Cross-Arms, under CIVIL ENGINEERING, *Materials of Construction*.

Lines

Transmission Lines versus Foreign Low-Potential Lines. J. G. Swain. A discussion of overhead line construction. 4000 w. *Elec Ry Jour*—June 15, 1912. No. 33750.

Line Transients

Factors in Line Transients. G. Facioli. Cites cases showing that switching should be confined to the low tension side in all cases where high tension switching is not absolutely necessary. 4000 w. *Gen Elec Rev*—June, 1912. No. 33375 C.

Protective Apparatus

Review of Recent Developments Related to Protective Apparatus. E. E. F. Creighton. Review of some of the more important devices recently developed for protecting electrical apparatus. 3500 w. *Gen Elec Rev*—June, 1912. No. 33379 C.

Rotary Converters

Rotary Converters and Their Operation. Norman G. Meade. Gives classification and discusses hunting regulation, and compounding. Ills. 1800 w. *Power*—June 25, 1912. No. 33914.

Transformers

General Trend of Development in Transmission and Distribution of Electric Power as Shown by Recent Transformer Production. W. S. Moody. Based on figures of the transformer business from the records of the General Electric Co. Ills. 1500 w. *Gen Elec Rev*—June, 1912. No. 33371 C.

Potential Transformer Testing. J. R. Craighead. Note on the effect of the resistance of the detector circuit, in determining the ratio of two alternating voltages, and the phase angle between them, by the balance method. 1200 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34087 F.

The Testing of Instrument Transformers. P. G. Agnew and F. B. Silsbee. Explains a modification of the potentiometer method recently developed at the Bureau of Standards. 700 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34093 F.

Measurement of Energy with Instrument Transformers. Alexander Maxwell. Considers aspects of the problem presented by the use of instrument trans-

formers in connection with watt-hour meters. 1500 w. *Pro Am Inst of Elec Engrs*—June, 1912. No. 34084 F.

Transformer Connections. Cecil P. Poole. Explains method of testing for three-phase transformer connections. Diagrams. 1500 w. *Power*—June 18, 1912. No. 33760.

Voltage Regulation

Automatic Voltage Regulation of Power Transmission Systems. H. A. Laycock. Describes various types of automatic voltage regulating apparatus. 900 w. *Gen Elec Rev*—June, 1912. No. 33376 C.

MISCELLANY

Australia

Electricity in Australia. O. W. Brain. Presidential address to Elec. Assn. of N. S. W. Showing progress during 21 years. 2500 w. *Aust Min Stand*—May 9, 1912. Serial. 1st part. No. 33797 B.

Copper

Copper Buying and Drawing. The Economy of the Draw-Bench. C. V. Rapiet. Discusses whether it pays to put in a draw-bench for drawing copper from rough rolled bar into rounds, flats, commutator bars, etc. 1500 w. *Elec Rev*, Lond—May 31, 1912. No. 33658 A.

INDUSTRIAL ECONOMY

Accounting

Reforming City Business Methods. U. L. Leonhauser. Explains the views and methods of a bureau organized to improve methods of municipal accounting and reporting. 2000 w. *Munic Jour*—June 6, 1912. No. 33486.

Cost Accounting in Lynn. Harry T. Rich. An explanation of the system in use in the Department of Streets and Highways. 2500 w. *Munic Jour*—June 6, 1912. No. 33484.

See also City Planning, under CIVIL ENGINEERING, *Municipal*.

Card Systems

Installation of the Card System for All Workmen of the Eschweiler-Reserve Mines in Nothberg (Einführung der Kartenkontrolle für die gesamte Belegschaft der Grube Eschweiler-Reserve bei Nothberg). Herr Beissel. Description of the mode of arrangement of the cards, and the utility of a time system. Ills. 2400 w. *Glückauf*—May 4, 1912. No. 33512 D.

Commerce

Commerce, the Commission and the Courts. Logan G. M'Pherson. A lecture at Cornell Univ. Discusses the conflict between the Commission and Courts. 4000 w. *Ry Age Gaz*—June 21, 1912. No. 33872.

Cost Methods

Cost Methods That Give the Executive Control of His Business. Benjamin A. Franklin. On the value of statistics and their study. Seventh of a series of articles. 2500 w. *Engineering Magazine*—July, 1912. No. 33967 B.

Economics

Regulation of Industries by Governmental Supervision. J. H. G. Wolf. A study of the influence of government upon economics, especially the changes of the last decade. 3500 w. *Jour Assn of Engng Socs*—May, 1912. No. 33815 C.

Education

"Men Wanted." Charles Whiting Baker. Address at Commencement of

Rose Polytechnic Inst., Terra Haute, Ind. Mainly discusses the relation of engineers to the public. 5000 w. *Eng News*—June 20, 1912. No. 33861.

The Status of Co-operative Schools. Charles H. Winslow. Favors the co-operative plan and gives descriptive analysis of the work at various schools. 4500 w. *Am Mach*—June 20, 1912. No. 33802.

A Training School for Automobile Workers. Describes features of a system established by the Cadillac Motor Car Co. to equip apprentices for their work. Ills. 1500 w. *Ir Age*—June 6, 1912. No. 33443 C.

Rise of German Factory Schools. Kurt Kohlmann. Explanation of developments which have caused a remarkable decrease in emigration. 2000 w. *Am Mach*—June 27, 1912. No. 33956.

Technical Education on the Rand. Brief outline of the general position of higher education in South Africa, with illustrated description of the School of Mines and Technology. 2800 w. *Engr*, Lond—May 17, 1912. No. 33276 A.

The Imperial College of Science and Technology. C. A. M. Smith. An explanation of the present state of affairs at this institution. Ills. 2500 w. *Engng*—May 24, 1912. Serial. 1st part. No. 33459 A.

Industrial Finance

Financing an Industry (Die Finanzierung der Industrie). Felix Somary. Reviews the necessary preliminary steps in the formation of any industrial plant. 3600 w. *Elektrotech u Maschinenbau*—June 2, 1912. No. 33547 D.

Industrial Property

The International Association for the Protection of Industrial Property. An account of the Congress recently held in London and some of the questions discussed by various members present. 5500 w. *Engng*—June 7, 1912. Serial. 1st part. No. 33787 A.

Labor

The New Eight-Hour Law. George A. King. Full text is given and discussed. 2000 w. Eng Rec—June 15, 1912. No. 33721.

Workmen's Compensation in Europe and America. Mancius Smedes Hutton. A synopsis of European legislation and its results. 6000 w. Engineering Magazine—July, 1912. No. 33969 B.

Labor Saving

The Replacement of the Man by the Machine. Henry Harrison Suplee. Considers the extent to which human effort has been relieved by mechanical devices and the effect on the mechanic. 3500 w. Cassier's Mag—June, 1912. No. 33847 B.

Management

The Fetishism of Scientific Management. John R. Edwards. A critical review of the doctrine, its aims, and accomplishments. 21000 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33825 H.

Economy in the Factory (Haushaltung im Fabrikbetriebe). H. Schwarz. Outlines several systems of practicing effective economy in shops and factories. Forms. Serial. 1st part. 2200 w. Zeit f Werkzeug—May 25, 1912. No. 33530 D.

See also Water Works Management, under CIVIL ENGINEERING, *Water Supply*.

Organization

Modern Organization. Charles Delano Hine. This seventh and last article of a series discusses the genesis and revelation of organization. 2000 w. Engineering Magazine—July, 1912. No. 33970 B.

Organization of the Bureau of Water Supply, City of New York. I. M. De Varona. Abstract of paper read before the Am W-Wks. Assn. Diagram and explanation of the general organization and its results. 2000 w. Eng Rec—June 15, 1912. No. 33726.

Power-Plant Efficiency as Determined by the Technical Education of Employees. C. M. Jansky. Report of an investigation made to determine whether the employment of technically trained men in fields usually occupied by unskilled labor increases the efficiency of the plant. 2500 w. Elec Wld—June 8, 1912. No. 33612.

Public Service Valuation

Development Cost or "Going Value" of Public Service Companies. From a report by Halbert P. Gillette to the Everett (Wash.) Light & Water Co. Gives the part bearing on this subject. 9800 w. Engng & Con—June 20, 1912. No. 34099.

Specialization

Mechanical and Commercial Limits of Specialization. Irvine Haworth. Considers the conditions under which specialization progresses. 3000 w. Prac Engr—May 31, 1912. No. 33666 A.

Strikes

The Coal Strike: Its Causes and Consequences. T. Good. Discusses this labor difficulty in Great Britain. 4000 w. Cassier's Mag—June, 1912. No. 33845 B.

Time Study

An Analysis of Practical Time-Motion Studies. George H. Shepard. A study of working methods preparatory to scientific rate fixing. 4000 w. Engineering Magazine—July, 1912. No. 33964 B.

To Reduce Costs, Study the Work. George K. Hooper. Discusses what cycle time study observations may accomplish. 2000 w. Ir Age—June 13, 1912. No. 33653 C.

Two-Turret Lathe Instruction Cards. H. W. Reed. Gives two cards based on elementary time study under the Taylor system, applying to two pieces made on a turret lathe. 1500 w. Am Mach—June 6, 1912. No. 33435.

See also Drilling, under CIVIL ENGINEERING, *Construction*.

Wages

A Review of Existing Wage Systems. C. B. Auel. Brief explanation of systems in use. 6500 w. Am Mach—June 13, 1912. No. 33641.

Wages Systems. J. Walter and A. E. Brewerton. Discusses the systems in use and explains a system evolved by the writers. 1700 w. Elec Rev, Lond—June 14, 1912. No. 33917 A.

The Minimum Wage in British Coal Mining (Der Mindestlohn im britischen Steinkohlenbergbau). Dr. Jüngst. Review of conditions in the British coal industry, and text of the Minimum Wage Bill. 3800 w. Glückauf—May 11, 1912. No. 33515 D.

MARINE AND NAVAL ENGINEERING

Battleships

U. S. S. Florida. Illustration, with description of vessel and machinery, and report of recent trials on the Rockland course. 11000 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33833 H.

Bulkheads

See Ship Design, under MARINE AND NAVAL ENGINEERING.

Canal Boats

Model Experiments on Canal Navigation and the Accompanying Effects Between Canal-Boats and Canal-Profiles (Modellversuche über den Schiffahrtsbetrieb auf Kanälen und die dabei auftretende Wechselwirkung zwischen Kanalschiff und Kanalprofil). H. Krey. Experiments on the design of canal boats to

give least resistance and wave action. Ills. 5000 w. Zeitschr d Ver deutscher Ing—May 18, 1912. No. 33574 D.

Compasses

Simplified Methods of Compass Correction. R. A. Koch. Describes methods that have worked successfully. 2500 w. Pro U S Naval Inst—June, 1912. No. 33976 E.

The Sperry Gyro-Compass. Illustrated detailed description of this compass which is in practical service. 3500 w. Engng—May 31, 1912. No. 33671 A.

Theory and Operation of the Gyroscope and the Sperry Gyroscopic Compass. R. E. Gillmor. Explains its principles and gives instructions for its care and operation. Ills. 8000 w. Pro U S Nav Inst—June, 1912. No. 33974 E.

The New Navy Gyroscopic Compass. Illustrated detailed description of the Sperry gyro-compass. 2500 w. Sci Am—June 29, 1912. No. 33988.

The Telefunken Compass. Illustrates and describes this new apparatus devised for the determination of direction by wireless, explaining the arrangement. 1500 w. Elect'n, Lond—May 24, 1912. No. 33448 A.

Cruisers

The Battle-Cruiser. Burnell Poole. Illustrations and descriptions of the British "Lion" and the German "Moltke" and their performance. 2000 w. Engineering Magazine—July, 1912. No. 33963 B.

The German Battle-Cruiser "Moltke." Illustrations with brief description of interesting features. 1200 w. Sci Am—June 22, 1912. No. 33866.

The Design of Cruisers. Brief discussion of recent changes and the difficulties due to the nature of the services of such ships. 2000 w. Engr, Lond—May 17, 1912. No. 33275 A.

The Launch of the Japanese Battle-Cruiser "Kongo." An account of the launching. 1500 w. Engng—May 24, 1912. No. 33464 A.

The Japanese Battle-Cruiser "Kongo." Elevation and plan, with photographs of the work in progress. Plate. 2200 w. Engng—May 17, 1912. No. 33272 A.

Diesel Engines

Diesel Engines for Naval Purposes. A. K. Atkins. A discussion of the advantages and disadvantages of types and of the Diesel engines over steam-driven ships. 6000 w. Pro U S Nav Inst—June, 1912. No. 33978 E.

Dredges

Plans for a Frühling Suction, Hopper Dredge (Entwurf eines Sauge-Hopper-Baggers nach dem System Frühling). M. Popp. Eight plates giving details for construction of this type of dredge. 4000 w. Schiffbau—May 8, 1912. No. 33539 D.

Exploration Ships

Ship Equipment for the Royal Biological Station at Heligoland (Dienst-

fahrzeug für die Königliche Biologische Station auf Helgoland). O. Flamm. Details in the design, construction and equipment of the exploratory ships in the service, especially the S.S. Augusta. Ills. and plates. 2200 w. Schiffbau—May 22, 1912. No. 33552 D.

Ferry-Boat

A Ferry-Boat Propelled by the Current. C. E. Chappell. Brief illustrated description of an arrangement on the Cumberland River, at Clarksville, Tenn. 500 w. Eng News—May 30, 1912. No. 33317.

Ice-Breaking Steamer

The Ice-Breaking Steamer "Pjotr Welikij." Illustrated description of a powerful vessel, built in Sweden, of interesting design. 700 w. Engng—June 7, 1912. No. 33786 A.

Melville

George Wallace Melville. Review of his career. Photograph. 12500 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33831 H.

Motor Boats

Motor Passenger Launch "Violeta." Illustrations with brief description. 600 w. Engng—May 31, 1912. No. 33673 A.

Naval Architects

The German Naval Architects. A report of the summer meetings of the Schiffbautechnische Gesellschaft, with abstracts of papers. 4000 w. Engr, Lond—June 14, 1912. Serial. 1st part. No. 33944 A.

Navigation Congress

International Navigation Congress Papers. Abstracts of some of the more important summaries of papers read in Philadelphia. 13000 w. Eng News—May 30, 1912. No. 33322.

Twelfth International Congress of Navigation. Report of the Philadelphia meeting, with abstracts of papers on inland and ocean navigation. 18500 w. Int Marine Engng—June, 1912. No. 33437 C.

The Twelfth International Navigation Congress in Philadelphia (XII. Internationaler Schifffahrtkongress in Philadelphia). This first of a series outlines some of the points to be considered at the meeting of the congress May 23 to 29, 1912. Serial. 1st part. 3200 w. Schiffbau—May 22, 1912. No. 33554 D.

Navy Yards

Inspection Duty at Navy Yards. D. Parker. Discusses the desirability of inspection departments, the methods and characteristics of efficient inspection, relations of the inspector, results, etc. 11500 w. Pro U S Nav Inst—June, 1912. No. 33971 E.

Oil Fuel

The Substitution of Combustible Liquids for Coal, in Regard to Navigation and Ports, and to the Port of Genoa in Particular (Sulla sostituzione del combustibile liquido al carbone, nei riguardi della

navigazione e dei porti, e del porto di Genova particolarmente). N. Ronco. Review of the adaptability of oil fuel for the purpose. 8100 w. Ann della Soc d Ing e d Arch Ital—May 16, 1912. No. 34010 E.

Power Boat

Power Boat to Attempt the Western Ocean Passage on a Voyage from Detroit to St. Petersburg, Russia. Plan and description of the vessel. 1000 w. Rudder—June, 1912. No. 33425 C.

Propellers

Screw Propellers. C. W. Dyson. The determination of diameter, pitch and projected area by means of the effective thrust. 1200 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33835 H.

See also Corrosion, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Searchlights

Searchlights. J. M. Heslop. Abstract of a lecture before the Sunderland Tech. College Engng. Soc. Discusses the value of marine searchlights on shipboard. Ills. 3500 w. Cassier's Mag—June, 1912. No. 33844 B.

Shipbuilding

Changes and Extensions in Clyde Shipbuilding Yards. An account of the more important changes and extensions. 2500 w. Engr, Lond — May 31, 1912. No. 33679 A.

Concerning Large Passenger Ships (Ueber grosse Passagierschiffe). R. Schmidt. Reviews the method of classification by tonnage of large ships. Ills. 3600 w. Schiffbau—May 22, 1912. No. 33553 D.

Ship Design

Water-Tight Sub-Division of Liners. William Hovgaard. Critical discussion of the construction of the "Titanic," with proposed modifications. 2500 w. Engng—May 24, 1912. No. 33463 A.

A Proposal for Increasing the Buoyancy of Large Ocean Steamers (Ein Vorschlag zur Erhöhung der Schwimmfähigkeit der grossen Ozeandampfer). Gustav Wrobbel. Plans for increasing thickness of the bow plates to prevent damage in collision. Plates. 1600 w. Schiffbau—May 8, 1912. No. 33540 D.

Increasing the Size of Ships (L'accroissement des dimensions des navires). L. E. Bertin. Mathematical discussion on

changes in formulae for such increased dimensions. 6300 w. Rev Gen des Sciences—May 30, 1912. No. 33596 D.

Steamships

The Cunard Liner "Aquitania." Photographs showing progress, with brief notes. 200 w. Engr, Lond — May 31, 1912. No. 33678 A.

New French Line Steamship France. Illustrated description of this most luxurious, largest, and speediest vessel of the French marine. 2500 w. Int Marine Engng—June, 1912. No. 33440 C.

Steam Turbines

Experience on the Trial Trip of a Turbine-Driven Naval Vessel. J. E. Snyder. Report of the recent standardization and endurance trials of the U. S. naval collier "Neptune." 2500 w. Elec Jour—June, 1912. No. 34038.

Titanic

Safety in Travel by Sea. Editorial critical review of the report of the U. S. Senate Committee which investigated the "Titanic" disaster. 3500 w. Eng News—June 6, 1912. No. 33494.

The "Titanic" Inquiry. A record of the evidence given on naval architectural and engineering questions. Plates. 1500 w. Engng—June 14, 1912. Serial. 1st part. No. 33940 A.

The "Titanic" Disaster: Its Lessons, and the Danger of Icebergs (La Catastrophe du "Titanic," ses enseignements, et le danger des icebergs). A. Deslisle. A review of opinion on either side of the Atlantic. Ills. 4000 w. Génie Civil—June 8, 1912. No. 34008 D.

Transport Ship

Vessel for Transporting Submarines. Illustrated description of the submarine transporting ship Kangaroo. 500 w. Engr, Lond—June 7, 1912. No. 33794 A.

Unsinkable Ships

Air to Keep the Water Out. Frank Richards. Suggestions for applications of compressed air to keep vessels afloat in emergencies. 3000 w. Compressed Air—June, 1912. No. 33841.

Yachts

Atair, a Twin-Screw Diesel Yacht. J. Rendell Wilson. Illustrated description of a pleasure boat built for Mr. Leloir, of Buenos Aires, driven by a Diesel engine. 1500 w. Rudder—June, 1912. No. 33424 C.

MECHANICAL ENGINEERING

AERONAUTICS

Aerodynamics

An Experimental Contribution to the Aerodynamics of Cylinders, and to the Study of the Phenomena of Magnus (Contribution expérimentale à l'aérodynamique du cylindre et à l'étude du phénomène de Magnus). M. Lafay. A study of air

currents about a moving cylinder. Ills. 15000 w. Rev de Mecan—May 31, 1912. No. 33593 E + F.

Aviation

Notes on Aviation. W. I. Chambers. Discusses safety in flight. Ills. 7500 w. Pro U S Naval Inst—June, 1912. No. 33979 E.

Motor Flight and Air Sailing or Gliding. Carl von Lilienbach. Abridged translation from *Fachzeitung für Flugtechnik*. Considers the ideal to be a machine capable of both kinds of flight. 2500 w. Sci Am Sup—June 8, 1912. No. 33473.

Charts

Charts for Aviators (Karten im Flugzeug). Hans Steffen. Describes some French topographic charts specially prepared and marked for the use of aviators. Plate. 2800 w. Motorwagen—May 10, 1912. No. 33558 D.

Design

The Structures of the Future in Relation to Aviation. Horace Cubitt. Read before the Inst. of Munic. Engrs., London. Discusses the construction of the workshops and housing sheds for aeroplanes. 3500 w. Archt, Lond—June 14, 1912. No. 33915 A.

Motors

American Aeronautic Motors. Stanley Yale Beach. Illustrated description of a new rotary motor and a six-cylinder engine with concentric valves. 1500 w. Sci Am Sup—June 1, 1912. No. 33286.

Navy

Aviation in the Navy. E. Lapointe. Discusses the governing principles of flying machines and the advantages to be expected from aviation in the Navy. 11000 w. Pro U S Naval Inst—June, 1912. No. 33977 E.

Stability

Graphic and Experimental Studies on the Stability of Aeroplanes in Calm and Rough Weather (Étude graphique et expérimentale de la stabilité de l'aéroplane en air calme et en air agité). A. Delaunay. The first part discusses longitudinal stability under the two conditions. Diagrams. Serial. 1st part. 2500 w. Tech Mod—June 1, 1912. No. 34004 D.

Wilbur Wright

Wilbur Wright. Obituary, reviewing his life-work in the field of aviation. 2000 w. Engr, Lond—June 7, 1912. No. 33795 A.

AUTOMOBILES

Agricultural

The Agricultural Motor Contest at Chelles. Lucien Fournier and L. W. Ellis. A comparison of European and American machines. Ills. 4000 w. Sci Am Sup—June 29, 1912. No. 33990.

See also Motor Plows, under *Automobiles*.

Austin

The 10-H. P. Austin. Illustrates and describes this improved model. 700 w. Auto Jour—June 8, 1912. No. 33766 A.

Battery Charging

Battery Charging Equipments for Electric Vehicles. T. H. Schoepf. Discusses the battery charging problem of a particular garage as an example. 1000 w. Elec Jour—June, 1912. No. 34040.

Chalmers

The 25-H. P. Chalmers Car. Illustrated description of details of interest in this moderately priced car. 1500 w. Auto Jour—May 18, 1912. No. 33258 A.

Clutch

The Polyrhoë Clutch. A simple metal cone clutch with a floating female cone carried on the clutch casing by a set of four disc-like pegs. Behind the female cone is a strong extra spring. Ills. 1500 w. Auto Jour—May 18, 1912. No. 33257 A.

Commercial Vehicles

See Electric Trucks and Motor Trucks, under *Automobiles*.

Cost

The Cost of Owning an Automobile. C. H. Calkins. Considers the items of expense in detail. 3000 w. Horseless Age—June 19, 1912. No. 33856.

Delaunay-Belleville

The 26 h. p. Delaunay-Belleville. Illustrated description of this 6-cylinder, 4-speed car. 1000 w. Autocar—June 8, 1912. No. 33767 A.

Design

See Flywheels, under *Machine Elements and Design*.

Electric Trucks

A Scientific Test of the Electric Truck. John Ritchie, Jr. An illustrated study of the comparative cost of horse-drawn and power vehicles. 1500 w. Sci Am—June 22, 1912. No. 33867.

Edison Electric Automobile. Remarks on the characteristics of the Edison battery with description of some of the automobiles using it. Ills. 2000 w. Elect'n, Lond—June 14, 1912. No. 33921 A.

Ford

Making the Ford Motor Car. O. J. Abell. Illustrates and describes the foundry, heat treatment and machine operations of the plant, with special reference to the apportioning of work. 3500 w. Ir Age—June 6, 1912. Serial. 1st part. No. 33441 C.

Garages

Practical Garage Fittings, and Book-keeping for Motor Omnibus Service (Zweckmässige innere Einrichtung von Garage und Buchhaltung bei Automobil-Omnibus-Linien). E. Vogl. Suggestions for public garage arrangements, and accounting methods. Plate. 4000 w. Motorwagen—May 31, 1912. No. 33560 D.

Instruction

See Education, under *INDUSTRIAL ECONOMY*.

Lanchester

The Lanchester Car. Illustrates and describes details of the design. 4000 w. Autocar—June 1, 1912. No. 33657 A.

Materials

Test Methods and Machines for Material Used by the G. Derihon Company (Materialprüfungsverfahren und Materialprüfmachine der G. Derihon-Gesell-

schaft). Ernst Valentin. Describes the various tests which this company places on all automobile parts. Ills. and plates. 7000 w. Motorwagen—May 20, 1912. No. 33559 D.

Motor Plows

Measuring Instruments for Investigating Motor Plows (Messinstrumente zur Untersuchung von Motorpflügen). Dr. Bernstein. Describes the various tests made for determining the power and efficiency of motor plows. Ills. 2800 w. Motorwagen—May 10, 1912. No. 33557 D.

Recent Motor Plows (Neuere Motorpflüge). K. Praetorius. A review of some of the plows as constructed in various countries. Ills. Serial. 1st part. 1400 w. Zeit d Mitt Motorwagen Ver—May 15, 1912. No. 33562 D.

Motors

Symposium on the Automobile Motor. J. B. Entz. The long-stroke motor is discussed by J. B. Entz; valve mechanism by Jas. G. Sterling; motor starting devices, by Harold B. Anderson. General discussion. Ills. 8500 w. Jour Cleveland Engng Soc—June, 1912. No. 34058 D.

Motor Trucks

Notes on Comparative Cost of Horse and Motor Truck Transportation in Engineering and Contracting Work. Rollin W. Hutchinson, Jr. Gives typical cases showing the ability of the motor truck to save money. Ills. 2000 w. Engng & Con—June 19, 1912. No. 33819.

Records of Motor Truck Transportation. Rollin W. Hutchinson. Discusses the questions to be considered in weighing a motor truck proposition. Ills. 2500 w. Ir Age—June 20, 1912. No. 33851.

Multiple Drives

Multiple Direct Drives for Gasoline Cars. Albert L. Clough. Discusses the merits of such arrangements. 2000 w. Horseless Age—June 19, 1912. No. 33857.

Packard

The Packard Six for 1913. Illustrates and describes improvements introduced. 1800 w. Automobile—June 20, 1912. No. 33855.

Panhard-Levassor

Oldest Car in the World. Illustrations and brief description of a 21-year-old automobile in France. 600 w. Automobile—June 6, 1912. No. 33487.

Repairs

First Aid for the Automobile. Illustrates and describes some road breakdowns and how to repair them. 3000 w. Automobile—May 30, 1912. No. 33335.

Rover

The 1912 18 h. p. Rover. Illustrated description of a new four-cylinder model with four speeds. 1000 w. Autocar—May 25, 1912. No. 33445 A.

Self-Starters

Self-Starters for Automobile Motors. Albert L. Clough. Considers the differ-

ent systems and their relative availability for old cars. 4000 w. Horseless Age—June 12, 1912. No. 33697.

Speedometers

See same heading, under *Measurement*.

Vulcanizers

Vulcanizing a Tire. Illustrates and describes hot and cold processes of repairing outer casings and inner tubes. 2200 w. Automobile—June 13, 1912. No. 33694.

The H. F. "Baby" Vulcanizer. Its capabilities of dealing with tire repairs are explained. Ills. 1500 w. Autocar—May 18, 1912. No. 33261 A.

Wheels

Testing Wheel Strength. Brief report of tests at Coventry, England, of wire, steel, and hickory types. Ills. 1500 w. Automobile—June 13, 1912. No. 33695.

On the Attachment of Detachable Wheels. John V. Pugh. Illustrates and describes the new Rudge-Whitworth detachable wheel and the self-tightening nut. 1000 w. Auto Jour—June 8, 1912. No. 33765 A.

A New Rudge-Whitworth Detachable Wheel. Illustrates and describes a new detachable system, especially the self-tightening and self-locking device. 1500 w. Autocar—May 18, 1912. No. 33259 A.

Winton

New Winton Out. Illustrates and describes the changes in new model. 2500 w. Automobile—June 27, 1912. No. 34107.

COMBUSTION MOTORS

Diesel Engines

The Present Status of the Diesel Engine in Europe, and a Few Reminiscences of the Pioneer Work in America. Rudolph Diesel. An illustrated review of the development in Europe and of pioneer work in America. 7500 w. Jour Am Soc of Mech Engrs—June, 1912. No. 34016 D.

The Diesel Engine from the User's Standpoint. William J. U. Sowter. Abstract of a paper before the Dublin Sec. of the I. E. E. Notes on its advantages, and maintenance. 2500 w. Elect'n, Lond—May 31, 1912. No. 33664 A.

Four Cylinder Four-Cycle Diesel Engines. Illustrates and describes examples for land and marine purposes. 3500 w. Engng—May 24, 1912. No. 33462 A.

The F. I. A. T. Diesel Motor. Deals particularly with a 4-cylinder engine of 100 h. p. Ills. 2500 w. Engr, Lond—May 31, 1912. No. 33676 A.

The Application of Diesel Engines to Locomotion and Navigation (Les applications du moteur Diesel a la locomotion et a la navigation). Rudolph Diesel. Discusses available oils for use, suggests adaptability for automobile propulsion, and describes the growth in maritime service. Ills. 3600 w. Tech Moderne—June 1, 1912. No. 34001 D.

See also same heading, under MARINE AND NAVAL ENGINEERING.

Gas-Engine Cycles

Mode of Cycle Regulation and the Construction of Internal Combustion Engines (Mode de Réglage Cycles et Construction des Moteurs à Combustion Interne). R. E. Mathot. Reviews the construction, ignition, compression, cooling and governing of modern two- and four-cycle engines. Ills. Serial. 1st part. 12100 w. All. Industrielle—June, 1912. No. 33599 D.

Gas Engines

330-Brake Horse Power Tandem Gas Engine. Illustrated detailed description of one of three engines recently constructed for Queensland. 2000 w. Engng—June 14, 1912. No. 33939 A.

Trebert Gasoline Engine. Illustrated description. 700 w. Power—June 4, 1912. No. 33422.

Gas Producers

Bituminous Coal Producers for Power. C. M. Garland. Describes the Apparatus and general arrangement of bituminous coal producers as designed for power. Ills. 5500 w. Jour Am Soc of Mech Engrs—June, 1912. No. 34015 D.

Oil Engines

What is the Future of the Oil Engine in the United States? G. H. Kimball. Reviews past experience with these engines, comparing types, and discussing features. 2000 w. Eng News—May 30, 1912. No. 33319.

See also Diesel Engines, under *Combustion Motors*, and under *MARINE AND NAVAL ENGINEERING*.

Producer Gas

Gasification of Inferior Fuels (Vergasung minderwertiger Brennstoffe). Herrn Mann und Uristefeld. Analytical discussion on the availability of inflammable material in gas producers. 3500 w. Glückauf—May 25, 1912. No. 33520 D.

The Use of the Hot Waste Gases from Reveratory Furnaces for Generating Steam (Die Verwertung der heissen Abgase von Flammöfen zur Dampfzeugung). F. Peter. General discussion on the heat available, and detailed outlines on the choice of boiler systems for such plants. Serial. 1st part. 4200 w. Stahl u Eisen—May 16, 1912. No. 33502 D.

Gas-Fired Furnaces and Gas-Power Plants with Chemically Regenerated Flue Gases (Gasfeuerungen und Kraftgasanlagen mit chemischer Regenerierung von Verbrennungsgasen). Herr Gwosdz. General remarks, and description of the Eldred gas-producer process. Ills. 2800 w. Glückauf—June 1, 1912. No. 33551 D.

Rotary Valve

Rotary Distributing Valve for Two-Stroke Internal-Combustion Engines. Illustrates and describes an invention by Alfred A. Scott, designed to insure better running of the engine under throttle and to enable the engine to develop its full power. 1000 w. Mech Engr—May 31, 1912. No. 33454 A.

Two-Cycle Engines

Investigations on the Working Process of a Two-Cycle Engine (Untersuchung des Arbeitsprozesses eines Zweitaktmotors). H. Scheit and Bobeth. Experiments and results on a Ferro motorboat engine of the two-cycle type. Ills. 5000 w. Zeitschr d Ver deutscher Ing—June 1, 1912. No. 33579 D.

HEATING AND COOLING**Air Conditioning**

Air Washers and Humidifiers for Public Buildings, Factories and Mines. Describes systems and apparatus used, explaining benefits. 3000 w. Sci Am Sup—June 8, 1912. No. 33474.

Combination Heating

Warm-Air and Steam Heating in Church. Illustrates and describes an installation at Malone, N. Y., to meet requirements of a cold climate. 2500 w. Met Work—June 7, 1912. No. 33600.

Furnace Heating

Ventilation and Rotation in Heating. Angus K. Campbell. Comments on general practices in warm-air furnace heating and the follies of over-ventilation. 2500 w. Met Work—June 14, 1912. No. 33691.

Ice Making

Technical Analysis of Typical Freezing Tank. Fred Ophuls. Considers some defects in freezing tanks used for ice making, analysis of the time required to freeze ice in artificial plants, etc. Ills. 7000 w. Ice & Refrig—June, 1912. No. 33602 C.

Making Ice with Heat. Frank C. Perkins. Illustrates and describes a type of automatic iceless refrigerator of English design for use in residences and hotels. 2000 w. Sci Am Sup—June 15, 1912. No. 33718.

Laboratories

Heating and Ventilating a Large Laboratory. Illustrates and describes details of equipment for providing warm fresh air and exhausting vitiated air in the Sloane Laboratory at New Haven, Conn. 2000 w. Met Work—June 14, 1912. No. 33690.

Neutral Zone

Neutral Zone in Heating and Ventilating. L. Biro. Explains the neutral zone and how it is determined in practice; interior conditions and methods of construction to lower or raise the neutral zone. 4000 w. Heat & Vent Mag—June, 1912. No. 34017.

Precooling

San Bernardino Precooling Plant. C. M. Gay. Illustrated description of this large plant for cooling of fruits and other products in refrigerating cars in transportation. 4000 w. Ry Mas Mech—June, 1912. No. 33747 C.

Precooling Plant of Southern Pacific. LeRoy W. Allison. Illustrated description of the plant at Colton, Calif., for

cooling perishable fruits, vegetables, etc. 1500 w. Power—June 4, 1912. No. 33423.

Refrigeration

Economies of Insulation. I. Lundgaard. How to compute the relative economy between increase of insulation or refrigeration. 1000 w. Ice & Refrig—June, 1912. No. 33603 C.

Store Heating

Steam Heating Large Department Stores. Davis S. Boyden. Read before the Am. Soc. of Heat. & Vent. Engrs. Gives results of tests of heating system in large store to show relation of heating to the electrical requirements. Ills. 2500 w. Met Work—June 28, 1912. No. 34095.

Ventilation

The Influence of Ozone in Ventilation. Leonard Hill and Martin Flack. Investigations seem to show its principal function to be that of a deodorizer. 5000 w. Sci Am Sup—June 1, 1912. No. 33288.

Ventilation of Restaurants. Charles L. Hubbard. Considers ventilation of the dining-room and kitchen. Ills. 1000 w. Dom Engng—June 1, 1912. No. 33391.

Ventilation on the Central London Railway. Describes the general principles of the ozonized air scheme, illustrating the plant used. 1000 w. Engr, London—May 17, 1912. No. 33280 A.

See also Tunnel Ventilation, under CIVIL ENGINEERING, *Construction*; and Ozone, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

HYDRAULIC MACHINERY

Hydraulic Jack

The Hydraulic Jack. An account of its invention, construction, and maintenance. Ills. 2000 w. Ry & Loc Engng—June, 1912. No. 33400 C.

Pipe Flow

Calculating the Flow of Water in Pipes. T. W. Holloway. Gives general formulae with illustrative examples. 2500 w. Power—June 4, 1912. No. 33420.

Resonance Indications in the Suction Pipes of Compressors and Gas Motors (Resonanzerscheinungen in der Saugleitung von Kompressoren und Gasmotoren). P. Voissel. Mathematical and graphical discussion on efficiency determinations from sound in the pipes. Ills. 3000 w. Zeitschr d Ver deutscher Ing—May 4, 1912. No. 33571 D.

Pumping Stations

See same heading, under CIVIL ENGINEERING, *Water Supply*.

Pumping Tests

Tests of Pumping Engines and Auxiliary Machinery in the New Water Filtration Pumping Station, New Orleans, La. L. E. Strothman. Gives results of very thorough tests of apparatus. Ills. 4500 w. Engng & Con—May 29, 1912. No. 33308.

Pumps

Turbine-Driven Centrifugal Pumps for Water-Works Service. Walter O. Beyer.

Abstract of paper before the Am. W-Wks. Assn. Aims to show that the combined fixed charges and operating costs of the rotary pumps compare favorably with those of other types where the price of coal is not excessive. 1800 w. Eng Rec—June 15, 1912. No. 33727.

The Variable Speed Drive for Centrifugal Pumps. Charles A. Carpenter. Aims to show that constant speed is not conducive to the best economy. 1000 w. Eng Rec—June 8, 1912. No. 33621.

A New Type of Centrifugal Pump for Low Heads at Steam Turbine Speeds. Charles A. Carpenter. Illustrated description of the Kerr centrifugal pump, with results of tests. 1000 w. Eng News—June 6, 1912. No. 33489.

Valves

See Castings, under *Machine Works and Foundries*.

MACHINE ELEMENTS AND DESIGN

Clutches

Design of Punch and Shear Clutches. Gives formulae and factors of design for the diameters, number of teeth, and depth of teeth. 1500 w. Am Mach—June 20, 1912. No. 33803.

See also same heading, under *Automobiles*.

Drafting

An Immense Drafting Organization. J. D. Mooney. An illustrated outline of the system of the Gen. Elec. Co. at Schenectady, N. Y. 4500 w. Am Mach—June 13, 1912. No. 33640.

Flywheels

The Gyrostatic Action of the Flywheel of an Automobile Engine. Barry McNutt. Explains the theory of gyrostatic action and shows that disturbances due to that cause are so small that they may be ignored. Ills. 2500 w. Horseless Age—June 26, 1912. No. 34106.

Notes on Flywheel Effect and Inertia of Large Rotating Masses. 500 w. Prac Engr—May 24, 1912. No. 33450 A.

Gears

Gear Data for Motor Applications. C. W. Drake. Gives a chart for determining approximate commercial values of pinion diameter, pinion face, diametral pitch, pitch line speed, and torque, with revolutions per minute and h. p. of motor given, with explanations. 1200 w. Elec Jour—June, 1912. No. 34045.

Processes in the Production of Gears. Walter Betterton. Read before the Birmingham Branch of the Inst of Auto. Engrs. Considers the processes of manufacturing gear-box gears by means of a complete equipment of gauges, tools, jigs, etc., with the object of ensuring interchangeability. Ills. 5000 w. Mech Engr—May 31, 1912. No. 33453 A.

Limits on Gearing. Francis W. Shaw. Discusses center to center distances of shafts and the pitch diameters of gears, and the degree of accuracy necessary to

secure interchangeability. 1500 w. *Prac Engr*—June 7, 1912. No. 33778 A.

Reminiscences of Oscar J. Beale. Luther D. Burlingame. Reviews his career, especially his work in gearing. Ills. 5000 w. *Am Mach*—June 27, 1912. No. 33955.

Patterns

A Storage for a Million Patterns. J. D. Mooney. Illustrates and describes a simple method of storing patterns in floor spaces, racks and bins. 1500 w. *Am Mach*—June 27, 1912. No. 33954.

Screw Cutting

Calculations for Wheel Motion in Screw-Cutting (Berechnung von Rädergetrieben zum Gewindeschneiden). W. Vorwerck. Presenting tables and formula for determining wheel ratios in screw sizes. Ills. 3500 w. *Zeit f Werkzeug*—May 15, 1912. No. 33528 D.

MACHINE WORKS AND FOUNDRIES

Annealing

An Automatic Annealing Furnace. Christian F. Meyer. Drawings and description of a furnace in which the intensity of the heat and the duration of the time the work is exposed, can be controlled to give uniform results. 1200 w. *Am Mach*—June 6, 1912. No. 33436.

The Vaughan-Hughes Method of Annealing Metals Without Oxidation. Illustrated description of the Vaughan-Hughes furnace and its work. 1400 w. *Brass Wld*—June, 1912. No. 33838.

Castings

Some Castings Troublesome to Run Up Sound. Walter J. May. Illustrates by examples, offering suggestions. Ills. 1000 w. *Mech Wld*—June 14, 1912. No. 33935 A.

Method of Making Dense Die Castings. Ethan Viall. Illustrates and describes details of die-casting machines which produce castings of the same or greater density than the ingot. 2000 w. *Am Mach*—May 30, 1912. No. 33312.

Making Panama Gate and Valve Parts. Ethan Viall. Illustrates and describes methods used to machine and gage some of the principal castings for these large parts. 1200 w. *Am Mach*—June 6, 1912. No. 33431.

Molding Architectural Bronze Castings. C. Vickers. Illustrates and describes intricate work. 1400 w. *Foundry*—June, 1912. No. 33409.

See also Chills, under *Machine Works and Foundries*.

Chills

New Process for Chilling Gray Castings. Thomas D. West. Gives results of a number of experiments for the mechanical production of outside and inside chills in iron castings. Ills. 7000 w. *Foundry*—June, 1912. No. 33411.

Chills for Metal Bedstead Brackets. Illustrates and describes details of chills used in casting rail brackets for large

and small posts. 2000 w. *Am Mach*—May 30, 1912. No. 33314.

Chip Briquetting

The Use of Briquettes for Improving the Quality of Castings (Brikettverwendung zur Herstellung von Qualitätsguss). J. Mehrrens. Results in the use of chip briquettes in a Berlin plant. Ills. 2700 w. *Zeit f Werkzeug*—May 5, 1912. No. 33527 D.

Dies

Force-Making for Embossing Dies. Chester L. Lucas. Explains the term "force" as used in connection with die-sinking, and illustrates and describes their making, the materials used, etc. 3500 w. *Mach, N Y*—June, 1912. No. 33346 C.

Drills

Design and Maintenance of Rock Drill Bits. Ward Blackburn. Discusses the cutting qualities, and the points of importance in a good bit. 2000 w. *Compressed Air*—June, 1912. No. 33842.

"American" Full Universal Radial Drill. Illustrated detailed description. 2500 w. *Prac Engr*—June 14, 1912. No. 33928 A.

Extrusion

An Experiment in Extrusion. Chester L. Lucas. Outlines an attempt made to apply the extrusion process to the making of wing-nuts and similar articles. Ills. 1200 w. *Mach, N Y*—June, 1912. No. 33353 C.

Factories

W. T. Henley's Telegraph Works Co.'s Cable Factories, Woolwich and Gravesend. Illustrated detailed description. 3500 w. *Elec Rev, Lond*—May 17, 1912. No. 33262 A.

Fire Drills

The Factory Fire Brigade and Drills. On the organization and duties of the shop fire brigade. 4500 w. *Am Mach*—June 27, 1912. No. 33957.

Foundries

American Foundries in the Light of German Criticism. From an address by C. Humperdinck, published in *Stahl und Eisen*. A comparison of practice. 900 w. *Castings*—June, 1912. No. 33798.

Features of a New Gray Iron Foundry. Illustrates and describes water boxes, portable jib cranes, cupola charging, safety jappanning ovens, etc., at a Cleveland, O., foundry. 2500 w. *Ir Age*—June 27, 1912. No. 33985 C.

Foundry Transportation

Modern Transport and Lifting Devices in Iron Foundries (Neuzeitige Transport- und Hebezeuge in Eisengiessereien). Hubert Hermanns. Review of cranes, conveyors, etc., employed in the various services of foundries. Ills. Serial. 1st part. 4800 w. *Giess Zeit*—June 1, 1912. No. 33543 D.

See also Cranes, under *Transporting and Conveying*.

Galvanizing

Dry Galvanization or Sherardizing (Ueber das Trockenverzinken oder Sherardisieren). Ernst Bernheim. Details of plant operation with the Sherardizing process. Ills. 1750 w. Stahl u Eisen—May 23, 1912. No. 33506 D.

Grinding

Grinding Wheel Efficiency. Revere Chapell. Discusses various conditions affecting wheels and their selection for the work. 1500 w. Am Mach—May 30, 1912. No. 33316.

The Grinding Process. Discusses its importance in the accurate production of motor car parts. Ills. 4000 w. Autocar—June 15, 1912. No. 33916 A.

Grinding Inserted Tooth Cutters. W. S. Tyler. Illustrates and describes a grinding device that aims to so grind the cutters that they will all cut evenly. 1500 w. Am Mach—June 13, 1912. No. 33643.

Jigs

Locating Jig Buttons. H. P. Fairfield. Illustrates and describes the method of setting jig buttons for accurately locating centers in the body or frame of drill jigs. 1500 w. Mach, N Y—June, 1912. No. 33348 C.

Lathes

The Value of a Small Lathe. Gives particulars of the work which can be undertaken, and details of the equipment. Ills. 3000 w. Autocar—May 18, 1912. No. 33260 A.

Lock Nuts

Lock Nuts. Suggestions for their successful manufacture. 1000 w. Prac Engr—May 17, 1912. No. 33237 A.

Machine Handles

Machine Handles. Fred Horner. Illustrated study of the various types of handles and handwheels used on machine tools. 3000 w. Mach, N Y—June, 1912. Serial. 1st part. No. 33350 C.

Machine Tools

Two New Machine Tools. Illustrates and describes a double-valve facing machine, and a boring and drilling machine, built in England. 1200 w. Engr, Lond—May 17, 1912. No. 33279 A.

Internal Cutting-Off Machine. Illustrates and describes special features of a new Newton machine. 1200 w. Ir Age—June 6, 1912. No. 33442 C.

Modern Machine Tools for Metal Work (Les machines-outils modernes pour le travail des métaux). E. Gay. This first of the series deals with the description of modern milling cutters. Ills. Serial. 1st part. 3500 w. Tech Mod—June 1, 1912. No. 34003 D.

Milling

Milling Main Rods at the Juniata Shops. Franklin D. Jones. Illustrates and describes the successive stages. 1200 w. Mach (Ry Ed)—June, 1912. No. 33634 C.

Milling Machines

History of the First Milling Machine. Joseph W. Roe. A brief history of the Whitney miller. Ills. 900 w. Am Mach—June 27, 1912. No. 33958.

Molding

Special Rigging and Equipment for the Foundry. Illustrated account of how molding economies are effected by the adoption of simple but practical devices for increasing the production. 1700 w. Foundry—June, 1912. No. 33407.

An Interesting New Device for Molding (Ein neues, interessantes Hilfsmittel in der Formerei). Description and uses of a new steel spiral for binding molds. Ills. 1400 w. Giess Zeit—May 15, 1912. No. 33509 D.

Planing Machine

Electrically-Driven Open-Side Planing Machine. Illustrated description of a British-built machine in which a novel form of driving has been adopted. 400 w. Engng—June 7, 1912. No. 33783 A.

Reamers

Vickers' Adjustable Reamer. Illustrated description. 800 w. Prac Engr—May 17, 1912. No. 33266 A.

Roll Turning

Turning Chilled Iron Rolls. F. B. Jacobs. Illustrates and describes the process and tools used. 1400 w. Mach, N Y—June, 1912. No. 33349 C.

Safety Devices

Safety as Applied to Engineering. C. Eugene Pettibone. Discusses developments in safety work. Ills. Discussion. 8500 w. Jour Cleveland Engng Soc—June, 1912. No. 34057 D.

Wisconsin's Orders on Safety. Gives general orders, and those applying to woodworking machines and freight elevators. 3000 w. Am Mach—June 20, 1912. No. 33805.

How Cambria Steel Co. Safeguards Its Employees. Illustrates and describes special equipment against accidents. 2500 w. Ir Trd Rev—June 13, 1912. No. 33693.

Safeguards for Electric Cranes. Edward K. Hammond. Illustrates and describes details of safety provisions and operation in the plant of the Illinois Steel Co. 2000 w. Ir Age—May 30, 1912. No. 33330 C.

Safeguards for Power Plant Equipment. Edward K. Hammond. Illustrates and describes devices for preventing accidents. 1500 w. Power—June 18, 1912. No. 33758.

See also same heading, under MINING AND METALLURGY, Coal and Coke; and Protective Apparatus, under ELECTRICAL ENGINEERING, Transmission.

Screw Cutting

See same heading, under Machine Elements and Design.

Screw Threads

Everyday Screw Thread Troubles. F. G. Coburn. Suggestions for remedying

defects. 2200 w. Am Mach—June 6, 1912. No. 33434.

Shears

New Crank Shears (Neue Kurbelscheren). C. Krügener. A new cutting machine acting with a toggle motion. Ills. 2100 w. Zeit f Werkzeug—May 25, 1912. No. 33529 D.

Shop Lighting

Daylight, Distinctive in Shop Lighting. C. E. Clewell. Ninth of a series of articles on shop lighting. Discusses requirements in providing adequate daylight and light control. Ills. 3500 w. Am Mach—June 6, 1912. No. 33433.

Shop Practice

Fitting Up Spare Engine Parts. J. Leslie. Describes the method used by a firm doing small marine work. Ills. 1000 w. Mech Wld—June 14, 1912. No. 33934 A.

Assembling and Reaming. Topical discussion, Feb. 12, 1912. Ills. 8000 w. Jour W Soc of Engrs—May, 1912. No. 33688 D.

Calculating Change-Wheels for Taper Turning. George W. Burley. Mathematical explanation. Ills. 900 w. Mech Wld—June 14, 1912. No. 33933 A.

Methods in a Southern Contract Shop. John S. Van Pelt. Illustrates and describes jigs and fixtures used in a repair shop. 2000 w. Am Mach—June 27, 1912. No. 33953.

Shops

Shop Arrangement as a Factor in Efficiency. Irvin Haworth. Discusses points that should be considered in modern works. 2200 w. Mech Wld—May 24, 1912. No. 33457 A.

A Large, Modern Wisconsin Machine Tool Plant. Illustrated description of the works of the Gisholt Machine Tool Co., at Madison, Wis. 3500 w. Ir Trd Rev—May 30, 1912. No. 33328.

The Siemens Manufacturing Concerns in Greater Berlin. Illustrated article describing works for the manufacture of electrical and engineering apparatus. 3500 w. Elect'n, Lond—June 7, 1912. No. 33771 A.

The Growth of the Thyssen & Co. Machine Shop in Mülheim-Ruhr (Die Entwicklung der Maschinenfabrik Thyssen & Co., A. G., in Mülheim-Ruhr). A. Wallichs. Describes appliances introduced since the opening in 1871. Ills. 1400 w. Stahl u Eisen—May 23, 1912. No. 33505 D.

Shop Shelves

Multiple-Unit Steel Shelving for Shop Use. Illustrated description calling attention to their advantages. 5000 w. Automobile—June 27, 1912. No. 34108.

Standardizing

Standardizing Elementary Parts. Rudolph L. Hanau. Shows how the work of designers and draftsmen can be simplified by using standards and the important

advantages. 2500 w. Am Mach—June 6, 1912. No. 33432.

Tapers

Tapers. George W. Burley. Critical discussion of the so-called "standard" tapers which are not "standard." 800 w. Mech Wld—May 24, 1912. No. 33455 A.

Tools

A Geared Tap Wrench. Drawings and description. 1000 w. Prac Engr—June 14, 1912. No. 33927 A.

Tools in a Cream Separator Plant. F. A. Stanley. Illustrates and describes interesting jigs and fixtures and special tools. 2000 w. Am Mach—June 20, 1912. No. 33800.

Tubing

Machine for Forming Flexible Tubing. Richard Toeplitz. Drawings and description of the machine and its operation. 1200 w. Mach, N Y—June, 1912. No. 33347 C.

Welding

A Theory of the Welding of Steel and Its Practical Application. Max Bermann. Condensed trans. from *Die Zeit des Ver. deut. Ing.* Explains phenomena observed in welding various sorts of steel and explains conclusions. Ills. 4500 w. Sci Am Sup—June 22, 1912. No. 33868.

Welding Brass by the Oxy-Acetylene Blowpipe. From *The Ironmonger*. Explains some of the causes of failure and how they may be avoided. 600 w. Brass Wld—June, 1912. No. 33840.

An Unusual Shaft Welding Job. H. R. Setz. Illustrates and describes the building up of a large gas engine crane shaft by the oxy-acetylene welding process. 800 w. Am Mach—June 20, 1912. No. 33804.

MATERIALS OF CONSTRUCTION

Alloys

German Silver and Similar Alloys (Ueber Neusilber und ähnliche Legierungen). H. Kloss. Giving percentage content of various alloys. Serial. 1st part. 2300 w. Giess. Zeit—May 1, 1912. No. 33507 D.

Aluminum

Modern Uses of the Metal Aluminum. Richard Seligman. From *Science Progress*. Illustrates and describes various applications to which its mechanical and chemical properties are adapted. 5500 w. Sci Am Sup—June 29, 1912. No. 33989.

Cast Iron

Malleable Cast Iron. James Aston. Discusses the fundamental principles and methods of controlling the chemical composition, temperature and time. Ills. 3000 w. Wis Engr—May, 1912. No. 33647 C.

Tests of Chillable Irons. Thomas D. West. Gives report of tests of the relative strength of gray iron and of part or wholly chilled iron, showing the best combination in chilled castings. Ills.

4500 w. Jour Am Soc of Mech Engrs—June, 1912. No. 33999 D.

New Processes for Chilling and Hardening Cast Iron. Thomas D. West. Outlines a series of experiments to determine the effect of different methods of treatment. Ills. 7000 w. Jour Am Soc of Mech Engrs—June, 1912. No. 33998 D.

The Physical and Chemical Properties of Cast Iron (Ueber die physikalischen und chemischen Eigenschaften des Guss-eisens). W. Venator. Review and discussion on article by John J. Porter in *Foundry Trade Journal*. 2500 w. Giess Zeit—May 1, 1912. No. 33508 D.

Corrosion

See same heading, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Iron

Foundry Iron. M. L. Smith. Discusses the effect of the metalloids and the condition of the carbon; the value of analysis, mixing, working, coke, etc. 5500 w. Ap Sci—May, 1912. No. 33646 C.

Metallography

A Metallographic Study of Failures in Metals Conducted at the U. S. Naval Engineering Experiment Station, Annapolis, Maryland. J. F. Daniels. Illustrated with photo-micrographs. 1500 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33828 H.

The Inner Structure of Metals. Sir J. Alfred Ewing. Abstract of the May lecture of the Institute of Metals. Reviews what the microscope has taught us concerning the structure of the simple metals. Ills. 4000 w. Engng—May 17, 1912. No. 33271 A.

Steel

The Importance of Incandescence in Steel Casting (Die Bedeutung des Glühens von Stahlformguss). P. Oberhoffer. A study of the crystalline structure of steel when cast at various temperatures. Ills. 3000 w. Stahl u Eisen—May 30, 1912. No. 33542 D.

Sound Variations in Steels in Functions of Their Temperature (Variations sonores des aciers en fonction de leur température). Felix Robin. Interesting experiments on the determination of the steel content from the vibrations emanating from heated bars. Diagrams. 57 pp. Rev de Metallurgie—June, 1912. No. 33591 H.

Steel Specifications

Society of Automobile Engineers Specifications for Steel. Reviews the more important parts of the specifications for the composition, heat treatment and properties of various kinds of steel. Supplement. 2500 w. Mach, N Y—June, 1912. No. 33351 C.

Tool Steels

A Study of the Proper Hardening and Classification of Tool Steels. W. B. Sullivan. A discussion of facts relating to the treatment of tool steel, and for secur-

ing more uniform results in the service of tools. Discussion. Ills. 7000 w. Pro of Ry Club of Pittsburgh—April 26, 1912. No. 33811 C.

Wire

The Uses of Copper-Clad Iron Wire. Considers tests made on duplex wires at Chester, Pa., and the uses made of this wire. 2500 w. Elec Rev, Lond—June 7, 1912. No. 33768 A.

Wrought Iron

The Value of Good Wrought Iron. Charles H. Reid. Remarks on good puddled iron and the process of making it. 2000 w. Ry Mas Mech—June, 1912. No. 33745 C.

MEASUREMENT

Calculating Machine

A New Calculating Machine. Illustrated description of the Schooling calculating machine intended to effect subtracting operations. 3000 w. Engr, Lond—June 14, 1912. No. 33947 A.

Calorimeters

Exhaust Gas Calorimeters for Internal Combustion Engines. John S. Nicholson, and Thomas B. Morley. Brief descriptions of three designs used, explaining their use in determining heat losses. Ills. 1200 w. Engng—May 31, 1912. No. 33670 A.

Thermo-Electric Bomb Calorimeters (Bombe Calorimétrique Thermo-Electrique). Ch. Féry. Description of bomb and tabular results of tests made on them. Ills. 2000 w. Gén Civ—May 25, 1912. No. 34006 D.

Compression Tests

The Theory of Material Changes under Rolls and Hammers (Die Theorie der Materialwanderung beim Walzen und Schmieden). Adolf Falk. Discusses the compression of metals and the changes taking place under compression. Diagrams. Serial. 1st part. 3000 w. Stahl u Eisen—May 16, 1912. No. 33503 D.

Extension Indicators

Optical Lead Extension Indicator. W. E. Dalby. Read before the Royal Soc. Illustrated description of the instrument, showing some of the diagrams obtained. 3000 w. Engng—June 7, 1912. No. 33790 A.

Laboratories

Machine Testing in the Technical High Schools of Berlin (Das Versuchsfeld für Werkzeugmaschinen an der Technischen Hochschule zu Berlin). G. Schlesinger. Description of laboratories, machines, and some of the research work accomplished by the school students. Ills. 2400 w. Zeitschr d Ver deutscher Ing—June 1, 1912. No. 33578 D.

Oil Testing

A New Oil-Testing Machine. C. H. Benjamin. Illustrated description of the machine and the behavior of an oil under test. 800 w. Am Mach—May 30, 1912. No. 33315.

Pyrometers

The Installation and Use of Pyrometers in Steel Mills. C. S. Gordon. Describes the equipment and methods of control at the Illinois Steel Co.'s works. 4000 w. Met & Chem Engng—June, 1912. No. 33412 C.

Slide Rule

A Sensitive Trigonometrical Slide Rule. An explanation of a new slide rule claiming to be specially adapted to survey work calculations. 1800 w. Engr, Lond—June 14, 1912. No. 33946 A.

Speedometer

Smith and Sons' New "Perfect" Speedometer. Illustrates and describes this instrument. 1000 w. Auto Jour—May 18, 1912. No. 33256 A.

Investigations on Rotary—Pendulum Speedometers (Untersuchung von Drehpendel—Geschwindigkeitsmessern). G. Breitung. Mathematical discussion on such an apparatus for the use of turbo-machines and other wheel-driven machinery. Ills. 1500 w. Zeit d Mitt Motorwagen Ver—April 30, 1912. No. 33561 D.

Tests

Test of an External Joint Film Oil Heater at the Engineering Experiment Station, Annapolis, Maryland. Describes the test, explaining its object, and giving results of the test determinations. Ills. 3000 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33827 H.

Testing Metals

Studies on Recent Methods for the Mechanical Testing of Metals (Étude sur les nouvelles méthodes d'essais mécaniques des métaux). R. Guillery. Reviews impact, torsion, tension and other tests; methods and machines for making them. Ills. 29 pp. Rev de Metallurgie—June, 1912. No. 33592 H.

Torsionmeter

The Gary-Cummings Torsionmeter. Illustrated description of the instrument as supplied to the U. S. S. "Florida." 1800 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33834 H.

POWER AND TRANSMISSION**Air Compressors**

Steam-Driven Compound Air-Compressor. Illustrated description of a design by the British Westinghouse Brake Co. 600 w. Engng—May 31, 1912. No. 33675 A.

Unloading Device for Air Compressor. Describes a motor-driven horizontal two-stage air compressor with a capacity of 4,000 cu. ft. of free air per minute, with a new unloading device which is under the direct control of the air governor. Ills. 400 w. Engr, Lond—May 24, 1912. No. 33466 A.

Air Compressor Explosion. William L. Affelder. Gives data furnished by a recording thermometer on the internal temperatures. 1200 w. Mines & Min—June, 1912. No. 33359 C.

Belts

Calculations on Driving Belts (Het berekenen van drijfriemen). J. C. Dijkhoorn. Discussion on the paper by C. O. Gerckens in *Zeitschr d Ver deutscher Ing*. Diagrams. 5000 w. De Ingenieur—May 18, 1912. No. 33584 D.

Cones

Comparison Between Flat and Steep Cones. H. A. Pearn. Gives reasons for using a cone designed so that the speed of the machine is either increased or decreased by altering the countershaft speed before altering the position of the cone belt. 700 w. Prac Engr—May 17, 1912. No. 33268 A.

Crank Drive

Change of Pressure and Thrust in Crank Driven Machines (Ueber Druckwechsel und Stösse bei Maschinen mit Kurbeltrieb). F. Döhne. Mathematical discussion. Ills. 4800 w. Zeitschr d Ver deutscher Ing—May 25, 1912. No. 33577 D.

Conveyor Belts

Feeders for Belt Conveyors. Colby M. Avery. Illustrates and describes types of 'automatic feeders. 1500 w. Eng & Min Jour—June 8, 1912. No. 33614.

Electric Power

The Proper Procedure in Factory Electrification. William B. Wrecks. Discusses adaptability, economy, and selection of motors. 1500 w. Elec Jour—June, 1912. No. 34043.

Electric Power in the Manufacture of Wooden Boxes. An illustrated article showing that by conserving and selling refuse it can be made profitable to purchase central station energy. 3500 w. Elec Rev & W Elect'n—June 15, 1912. No. 33741.

Electricity in Foundries. Comments on motors for cupola blowers, lifting magnets, and lighting; giving data of typical installations. Ills. 3000 w. Elec Rev & W Elect'n—June 8, 1912. No. 33608.

Motor-Drive in the Machine Shop. George H. Hall. Outlines the principles of motor application, and suggests methods by which belt-driven tools may be accommodated to motor drive. Ills. 5000 w. Mach, N Y—June, 1912. No. 33354 C.

Wiring and Motor Installation in a Large Machine Shop. Guy R. Grove. Illustrated description of a factory installation at Bradley, Ill. 2500 w. Elec Rev & W Elect'n—June 8, 1912. No. 33609.

A Motor-Driven Piano Factory. W. J. Kyle. Illustrates and describes the plant of the Schumann Piano Co., Rockford, Ill. 1800 w. Elec Jour—June, 1912. No. 34039.

Gas Power

The Use of Gas for Heat and Power: the Testing of Gas. E. B. Rosa. Lecture at centenary celebration of gas as an illuminant, Franklin Inst., Philadelphia,

Pa. 10000 w. Am Gas Lgt Jour—June 24, 1912. No. 33885.

High-Pressure Gas for Manufacturing Purposes. A. W. Onslow. Abstract of a paper before the Inst. of Gas Engrs. Discusses gas furnaces, the lighting and heating by high-pressure gas, etc. 2000 w. Ir & Coal Trds Rev—June 14, 1912. No. 33950 A.

Power Resources

Our Sources of Power: With Special Reference to Highland Water Power. Alex. Newlands. Abstract of a paper read before the Inverness Sci. Soc. & Field Club. Mainly a discussion of the water power possibilities of Great Britain. 2500 w. Ir & Coal Trds Rev—May 24, 1912. No. 33471 A.

Safety Devices

See same heading, under *Machine Works and Foundries*.

Screw Jacks

Screw Jacks for Lifting. Walter Heap. Gives a suggested design, explaining its advantages. 1500 w. Am Mach—June 13, 1912. No. 33642.

See also Hydraulic Jacks, under *Hydraulic Machinery*.

Turbo-Blowers

Construction and Operation of Turbo-Blowers and Compressors. Franz zur Nedden. First of a series of articles discussing the mechanical evolution and operating economy of turbine machines for handling air or gases. Ills. 2500 w. Engineering Magazine—July, 1912. No. 33965 B.

Modern Blowers and Compressors. Presents the advantages of new turbo-blowers and turbo-compressors. Ills. 1200 w. Prac Engr—June 14, 1912. No. 33926 A.

Turbo Blowers and Turbo Compressors. Gives particulars of trials made at Frankenthal. Ills. 1800 w. Ir & Coal Trds Rev—May 31, 1912. No. 33681 A.

STEAM ENGINEERING

Accumulators

Steam Regenerative Accumulators. D. B. Morison. Reviews installations showing the economies effected by utilizing exhaust steam in turbines, explains the principle of the Rateau accumulator and its value in turbine plants. Ills. 8000 w. Trans Inst of Engrs & Shipbldrs in Scotland—March 19, 1912. No. 33812 N.

Boiler Design

Innovations in the Construction of Boilers and Stokers (Innovazioni nella costruzione della caldaie a vapore e dei caricatori di combustibile). R. Klein. Reviews modern practice in boiler design. Ills. Serial, 1st part. 2800 w. Industria—May 26, 1912. No. 34012 D.

Boiler Plates

Experiments on Overlapped Arched Boiler Plates (Versuche mit überlappt geschweißten Kesselblechen). Peter Zwiauer. Tabulated results of such ex-

periments. 1800 w. Zeitschr d Ver deutscher Ing—June 1, 1912. No. 33581 D.

Boilers

Modern Boiler Problems. E. D. Meier. Reviews the various problems that have arisen in steam boiler practice and how they have been solved. 4000 w. Sib Jour of Engng—June, 1912. No. 34028 C.

Master Boiler Makers' Association. Report of the Pittsburgh Convention, with abstracts of papers. 10500 w. Am Engr—June, 1912. No. 33605 C.

The Solignac-Grille Boiler. Sectional view and description of a water-tube boiler in which the steam in formation does not pass through the water. 1200 w. Power—June 18, 1912. No. 33759.

The New Niclausse Boiler Construction (Die neue Bauart des Niclausse-Kessels). F. Geiseler. Details of the recent changes in the design of this boiler. Ills. 2700 w. Zeitschr d Ver deutscher Ing—May 18, 1912. No. 33573 D.

Boiler Scales

Device for Preventing the Deposit of Scale and for Purifying the Water in Locomotive Boilers. V. Artiche. Illustrated description of the device, explaining the advantages claimed. 3900 w. Bul Int Ry Cong—June, 1912. No. 33995 G.

Boiler Testing

Steam Boiler Testing. John O. Steger. A guide to students taking up for the first time the subject of boiler testing. 7000 w. Jour U S Art—May-June, 1912. No. 33982 D.

Evaporation Tests on a Double Flue Boiler Equipped with the Wefer Gas-Fired Furnace (Verdampfungsversuch an einem mit Wefer-Gasfeuerungen ausgerüsteten Zweiflammrohrkessel). Herrn Bütow and Doppelstein. Description of plant and results of tests. Ills. 1800 w. Glückauf—May 18, 1912. No. 33516 D.

Boiler Tubes

Making Charcoal Iron Boiler Tubes. George Thomas. Reviews the history of charcoal iron, its qualities, the method of production, and the process involved in the manufacture of boiler tubes. Ills. 1500 w. Power—June 11, 1912. No. 33629.

Condensation

Recent Development in the Rotary Air Pump and Condenser. C. E. C. Shawfield. Describes pumps evolved by Maurice Leblanc and by E. S. G. Rees, stating their advantages and disadvantages. Ills. 3000 w. Elect'n, Lond—June 14, 1912. No. 33918 A.

Engines

American Type of Uniflow Steam Engine. Illustrated description of the Nordberg uniflow engine. 1000 w. Power—June 11, 1912. No. 33630.

Engine Testing

A New Analysis of the Cylinder Performance of Reciprocating Engines. J. Paul Clayton. Describes investigations

resulting from extensive study of indicator diagrams. Part I. gives the approximation of actual steam consumption from indicator diagrams; and Part II. applies the logarithmic diagram to all elastic media. Ills. 104 pages. Univ. of Ill., Bul 58—May 6, 1912. No. 33980 N.

Engine Troubles

Water in the Low-Pressure Cylinder. H. R. Low. Explains where the water comes from. 1000 w. Power—June 25, 1912. No. 33913.

Flue-Gas Analysis

CO₂ Recorders. A. Vincent Clarke. Shows them to be essential for the attainment of maximum efficiency of combustion. 1000 w. Power—June 11, 1912. No. 33631.

Fuel

Dried Bagasse as Fuel. A report of tests carried out on boiler plants using this refuse for steam raising. 1500 w. Engng—May 31, 1912. No. 33672 A.

Fuel Oil

Oil-Fired Furnaces (Ueber einen Schmelzofen mit Oelfeuerung). Wilhelm Venator. Some of the advantages of such systems, with designs for burners and furnace arrangement. Ills. Serial. 1st part. 1200 w. Giess Zeit—June 1, 1912. No. 33544 D.

The Application of Coal Tar for Heat and Power Use (Teerölverwertung für Heiz- und Kraftzwecke). R. Hausenfelder. Description of burners, their arrangement, and the operation of such a plant, with results from the use of such fuel. Ills. 4600 w. Stahl u Eisen—May 9, 1912. No. 33501 D.

Indicator Cards

A New Analysis of Indicator Cards. Adapted from a paper by J. Paul Clayton. Describes means of determining from an indicator diagram an almost complete analysis of the cylinder performance. 3500 w. Power—June 18, 1912. No. 33757.

Smoke

The Dividends That Float Up the Chimney. S. B. Flagg. A discussion of fuel economy and what smoke means in dollars and cents. Ills. 2000 w. Sci Am—June 15, 1912. No. 33715.

Smokeless Chimneyless Steam Plants. Illustrates the municipal electric light and power station at Lichtenberg and the results of artificial draught. 1000 w. Sci Am Sup—June 8, 1912. No. 33472.

Stoker Test

Report of Test of a Murphy Stoker on a Babcock & Wilcox Boiler at the Naval Gun Factory, Washington, D. C. Illustrated description of boiler and appurtenances with report of tests. 2000 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33830 H.

Superheaters

The High Degree Superheater: Its Economy, Operation and Maintenance.

Gilbert E. Ryder. Read before the New England R. R. Club. Ills. 5300 w. Boiler Maker—June, 1912. No. 33696.

See also same heading, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Superheating

The Use of Superheated Steam. John S. Leese. Considers points in connection with its adoption. 2000 w. Prac Engr—May 24, 1912. Serial. 1st part. No. 33449 A.

Efficiency Tests on a Central Superheater (Leistungsversuch an einem Zentralüberhitzer). Paul Koch. Tables, methods and mathematical determinations for efficiency. Ills. 2700 w. Zeit f d Ges Turbinenwesen—May 30, 1912. No. 33556 D.

Turbines

New Developments in Steam Turbine Engineering. Edwin D. Dreyfus. Brief review of early development, and discussion of progress, service and applications. Ills. General discussion. 10500 w. Jour W Soc of Engrs—May, 1912. No. 33687 D.

A New Steam Turbine. Brief illustrated description of the recently developed De Laval multi-cellular type. 2500 w. Ir Age—May 30, 1912. No. 33331 C.

The Speed Problem in Steam Turbine Design. Compiled from advance sheets of a book issued by the De Leval Co. Discusses its solution, with special reference to a new type of turbine. Ills. 5800 w. Ind Engng—June, 1912. No. 34055 C.

Turbine Material

Metals Employed in the Construction of Steam Turbines (De l'emploi des métaux dans la construction des turbines a vapeur). Pierre Breuil. Discusses alloys and material in several designs, and suggest qualifying conditions to be met by their use in the various parts of turbines. 5600 w. Tech. Mod.—June 1, 1912. No. 34002 D.

Turbine Operation

On the Best Distribution of Load Among a Number of Similar Steam-Turbine Stages Working in Series. E. Buckingham. States the problem and gives mathematical reasoning. 1800 w. Jour Am Soc of Nav Engrs—May, 1912. No. 33832 H.

Turbine Testing

Parsons-Turbine Determinations (Zur Berechnung der Parsons-Turbine). August Kriegbaum. Mathematical determinations of efficiency under given conditions. Diagrams. Serial. 1st part. 1600 w. Zeit f d Ges Turbinenwesen—May 10, 1912. No. 33555 D.

Water Hammer

The Danger of Water Hammer. Report on a boiler explosion at a Yorkshire colliery caused by water hammer action.

Ills. 1200 w. Col Guard—May 31, 1912. No. 33669 A.

Water Hammer and Its Elimination. John S. Leese. Deals with the rules governing water hammer, the phenomenon in steam lines, and the successful elimination. 2000 w. Mech Wld—May 31, 1912. No. 33668 A.

TRANSPORTING AND CONVEYING

Aerial Tramways

The Elba Iron Ore Loading Plant. Illustrated description of an interesting plant for handling the extensive deposits of iron ore on the island of Elba. 1500 w. Sci Am Sup—June 1, 1912. No. 33285.

Ore Transporting on Island of Elba. C. A. Tupper. Illustrates and describes the aerial tramways and other arrangements for unloading and conveying materials. 1600 w. Ir Age—June 20, 1912. No. 33852.

Suspended Railways or Fixed Cableways (Schwebebahnen oder feste Seilbahnen). R. Zehnder-Spörry. Discussion on the relative merits of either system as shown in the Alpine roads. 4000 w. Zeit d Oest Ing u Arch Ver—June 7, 1912. No. 33568 D.

Cranes

A Comparison in Crane Girder Design. Edward G. Fiegchen. Introductory remarks on the need of suitable standards of strength and performance in crane design, and compares alternative designs for a pair of overhead crane girders with respect to their performance. Ills. 700 w. Mech Wld—June 7, 1912. Serial. 1st part. No. 33781 A.

New Foundry Cranes (Neuere Giessbettkrane). F. Heym. A recently built travelling crane with two lifting magnet arms, and a third battering arm capable of delivering blows at the rate of 60 per minute, for breaking up gray iron, etc. Ills. 2400 w. Stahl u Eisen—May 2, 1912. No. 33500 D.

See also Foundry Transportation and Safety Devices, under *Machine Works and Foundries*.

MISCELLANY

Acetylene

Acetylene Lighting. Vivian B. Lewes. First of these articles discussing the use of acetylene for domestic lighting. The present number considers the manufacture of calcium carbide. 1000 w. Archt, Lond—May 31, 1912. Serial. 1st part. No. 33655 A.

China

Primitive Methods and Tools in China. F. A. Foster. Illustrates and describes primitive tools, some of which are still in use. 2000 w. Am Mach—June 20, 1912. No. 33801.

Cotton Gin Machinery

Special Cotton-Gin Machinery. Ethan Viall. Illustrated detailed description of the brushes used to remove cotton lint from the saw teeth, and other interesting devices. 2500 w. Am Mach—June 13, 1912. No. 33639.

Gas Industry

Commercial and Financial Aspects of the Gas Industry. George B. Cortelyou. Lecture delivered at the celebration of the centenary of the introduction of gas as an illuminant. Reviews the history, the production and prices, and related matters. 10000 w. Jour Fr Inst—June, 1912. No. 34024 D.

Match Plates

The Manufacture of Aluminum Match Plates. H. Cole Estep. Illustrates and describes details of Goodale Co.'s process. 4000 w. Foundry—June, 1912. No. 33408.

Paper Mills

The Plant of the Spanish River Pulp & Paper Mills, Limited. Illustrated description of the plant, its equipment, and operation. 1500 w. Can Engr—June 6, 1912. Serial. 1st part. No. 33633.

Vacuum Cleaning

Vacuum Cleaning Equipment on Steamship. Drawings and description of details of an automatic vacuum cleaning system and machine operated by steam. 1200 w. Met Work—June 28, 1912. No. 34094.

MINING AND METALLURGY

COAL AND COKE

Accidents

Preliminary Statement on Coal Mine Accidents in the United States. Statistics covering 1910, 1911 and the first four months of the current year. 1200 w. U S Bureau of Mines—June, 1912. No. 33949 N.

Analysis

The Chemical Characteristics of Lignite (Zur chemischen Charakteristik der Braunkohlen). Ed. Donath. Analytic methods of comparison for various lig-

nites. 3300 w. Oest Zeit f Berg u Huttenwesen—May 25, 1912. No. 33511 D.

Breakers

The Buck Mountain Coal Breaker. Illustrated description of the most advanced practice in cleaning and preparing anthracite. 3500 w. Mines & Min—June, 1912. No. 33355 C.

Briquettes

Briquette Plant for the Italian Navy. Brief illustrated description of a plant for making "eggettes." 800 w. Col Guard—May 24, 1912. No. 33458 A.

British Columbia

Coal Resources of the Upper Skeena—Mining Developments Around Hazelton. Describes the country opened by the Grand Trunk Pacific and the resources, including an immense deposit of anthracite. Maps and Ills. 6500 w. B C Min & Engng Rec—April, 1912. No. 33951.

China

Experiences on a Chinese Coalfield. George S. Caldwell. Abstract of a paper read before the Manchester Geol. & Min. Soc. An account of the Lai Heu Ho coalfield, the method of working and Chinese characteristics. 2000 w. Ir & Coal Trds Rev—May 17, 1912. No. 33282 A.

Coal-Cutters

A Rope-Driven Coal-Cutter. Wilfred L. Spence. Read before the Inst. of Min. Engrs. Illustrates and describes the machine and method of driving. 3000 w. Col Guard—June 7, 1912. No. 33783 A.

Coal Dust

See Explosions, under *Coal and Coke*.

Coal Storage

A Submerged Coal Storage Pit at Omaha. Illustrated detailed description of the structural features. 1500 w. Eng Rec—June 15, 1912. No. 33719.

Deterioration and Spontaneous Heating of Coal in Storage. Horace C. Porter and F. K. Ovitz. A summary of results thus far obtained by the Bureau of Mines investigations. 4000 w. U S Bureau of Mines—Tech. paper No. 16. No. 33806 N.

Coal Structure

The Use of X-Rays in the Examination of Coal. F. C. Garrett, and R. C. Burton. Read before the N. of Eng. Inst. of Min. & Mech. Engrs. Also discussion. Illustrations and report of results. 2200 w. Ir & Coal Trds Rev—June 7, 1912. No. 33796 A.

Explosions

The Coaldust Question. W. E. Garforth. Abstract of presidential address to the Inst. of Min. Engrs., dealing with the danger of coal dust in mines. 5000 w. Col Guard—June 7, 1912. No. 33785 A.

Explosives

Explosives in Coal Mines. Gives an important new order issued May 21, 1912, regulating the supply, use and storage of explosives. 2500 w. Col Guard—June 14, 1912. No. 33936 A.

Geology

An Occurrence of Coal Which Bears Evidence of Unusual Conditions Accompanying Its Deposition. Jesse E. Hyde. Illustrated description of an occurrence at Somerset, Ohio, discussing the probable formation. 5000 w. Jour of Geology—May-June, 1912. No. 33981 E.

Kentucky

Progress in Kentucky Geology. Brief reports on various districts examined and work done in the correlation of coal seams. 1200 w. Mines & Min—June, 1912. No. 33358 C.

Legislation

Anti-Trust Laws and the Coal Industry. Glenn W. Traer. Explains the effect of the Sherman Act and the Illinois Act on the producers of bituminous coal, preventing them from taking steps for needed protection. 3500 w. Mines & Min—June, 1912. No. 33357 C.

Lookout Mountain

Lookout Mountain Coal Measures. A. W. Evans. Information concerning the structure, quality of the coal, cost of mining, etc. Ills. 1600 w. Mines & Min—June, 1912. No. 33360 C.

Mine Pillars

Why Leave Shaft Pillars? W. H. Pickering and Basil H. Pickering. Read before the Inst. of Min. Engrs. Discusses the effect of crush in coal mining and surface subsidence, the size of shaft pillars, suggestions for opening a seam without having coal shaft pillars, and gives a summary of conclusions. 2500 w. Col Guard—June 7, 1912. No. 33782 A.

Safety Devices

Safety Devices in Connection with Electrical Machinery and Apparatus for Coal Mines. David Bowen and Walter E. French. From a paper read before the Inst. of Min. Engrs. Discusses features in connection with the safe application of electricity in coal mines. 3500 w. Col Guard—June 7, 1912. Serial. 1st part. No. 33784 A.

Washing

Experimental Coal-Washing Plant at McGill University. From a report by Dr. J. B. Porter on Canadian coals. Describes washing tests and the McGill plant, and discusses the subject of coal-washing generally. Ills. 2000 w. Col Guard—May 17, 1912. No. 33270 A.

Developments at Cortonwood Colliery. Illustrated description of the Humboldt coal-washing plant and arrangement of coke ovens at this colliery. Plate. 1500 w. Ir & Coal Trds Rev—May 24, 1912. No. 33469 A.

COPPER**Assaying**

Iodide Method of Copper Assay. Thorington Chase. Explains a method of analysis for certain ores, which gives most accurate determinations. 1500 w. Mines & Min—June, 1912. No. 33369 C.

Copper Determinations at Granby. Frank E. Lathe. Describes the uses and limitations of the electrolytic, iodide, cyanide, and colorimetric methods. 2500 w. Eng & Min Jour—June 1, 1912. No. 33339.

Japan

The Osaruzawa Mine. An account of one of the important copper mines of Japan. 1400 w. Min & Sci Pr—May 25, 1912. No. 33299.

New Mexico

The Chino Copper Co. Illustrated description of a large low-grade copper

property and its developments. 2200 w. Mines & Min—June, 1912. No. 33363 C.

Work of the Chino Copper Company. D. C. Jackling. Information from the annual report for the period ending Dec. 31, 1911, concerning the development and improvement at the mine, operations, etc. Ills. 2200 w. Min & Sci Pr—May 25, 1912. No. 33300.

Refining

The Refining of Blister-Copper. Horace H. Emrich. Part I. discusses a partial refining in the anode furnace; and Part II. considers electrolytic refining. General discussion. 8000 w. Bul Am Inst of Min Engrs—June, 1912. No. 34050 F.

Smelting

Copper Smelting at Kyshtim. Ernest J. Carlyle. Illustrates and describes a modern copper smelter in operation in the Urals. 4000 w. Eng & Min Jour—June 22, 1912. No. 33890.

Ural

Copper Mines of the Ural Region. H. W. Turner. Describes the mines of this region, which have been worked for 170 years. Ills. 3500 w. Min Mag—June, 1912. No. 33994 B.

GOLD AND SILVER

Amalgamation

Amalgamation Tables for Huntington Mills. Drawings and description. 700 w. Eng & Min Jour—June 1, 1912. No. 33340.

Australia

Early Days at Kalgoorlie. H. E. West. An interesting account of early conditions, about 1895. Ills. 2500 w. Min Mag—June, 1912. No. 33992 B.

British Columbia

The Origin of the Silver-Lead Deposits of East-Kootenay, British Columbia. S. J. Schofield. Discusses the origin of these ores and compares them with the similar deposits in Idaho. 2500 w. Ec-Geol—June, 1912. No. 34021 D.

Cobalt

Power Development in Cobalt. G. C. Bateman. Illustrated description of the water development to furnish power for the silver mines. 1200 w. Can Engr—June 20, 1912. No. 33905.

Cyanide Meters

Solution Meter for Use in Cyanide Plants. James Spiers. Trans. Am. Met. Soc. Describes the Worthington liquid weigher, used generally for measuring water, but also for oil and other liquids. Describes its adaptation for use in cyanide plants in the determination of solutions. 1000 w. Min & Engng Wld—June 1, 1912. No. 33397.

Cyaniding

The Action of Mineral Sulphates and Arsenates on Cyanide Solutions. Andrew F. Crosse. Report of experimental study and results. 2000 w. Jour Chem, Met & Min Soc of S Africa—April, 1912. No. 33764 E.

Laboratory Test on Cyanide Ore. Linderfelt and Stewart. Explains method used to determine the suitability of the ore to treatment by the cyanide process. 1500 w. Mines & Min—June, 1912. No. 33362 C.

Cyaniding at Nova Scotia Mill. C. L. Hargrave. Brief review of troublesome features of cyanidation, with suggestions for remedies. 2000 w. Eng & Min Jour—June 8, 1912. No. 33615.

Electric Furnaces

Electric Furnace at Lluvia de Oro. H. R. Conklin. Illustrated description of an electric furnace in Mexico, the first to be used for melting precipitate or smelting gold-silver concentrate. 3500 w. Eng & Min Jour—June 15, 1912. No. 33734.

Hydraulic Mining

The Conservation of Water for Hydraulic Sluicing. S. R. Stone. Gives particulars of difficulties overcome at the Palmer River district, of Queensland. 2000 w. Min & Engng Wld—June 1, 1912. No. 33393.

Hydraulic Mining in Beauce County, Que. Fritz Cirkel. An illustrated account of the hydraulic working of alluvial gold gravels. 4000 w. Eng & Min Jour—June 1, 1912. No. 33342.

Idaho

Genesis of Lead-Silver Ores in Wardner District, Idaho. Oscar H. Hershey. Map, and description of this district and its mineralization. 3000 w. Min & Sci Pr—June 1, 1912. Serial. 1st part. No. 33475.

Progress in the Coeur d'Alene District, Idaho. Stuart Rice. Illustrated historical review of the development of this region, with information concerning the problems and their solutions. 2500 w. Min & Engng Wld—June 3, 1912. No. 33635.

Leadville

Some Recent Developments at Leadville. G. Montague Butler. Describes a fissure vein recently discussed, discussing the origin of the deposits. 2500 w. Ec-Geol—June, 1912. No. 34018 D.

Mexico

A Geological Study of the Elisa Mine, Sonora, Mexico. A descriptive study of the geology and ore deposits of this region. Ills. 3000 w. Ec-Geol—June, 1912. No. 34019 D.

Mine Plant

A Cripple Creek Ore and Waste Plant. S. A. Worcester. Elevations and description of the ore house and details of hoisting bucket. 1000 w. Eng & Min Jour—June 15, 1912. No. 33731.

Nevada

Mining and Milling Costs in the Gold-field District. A. H. Martin. A report of present and past costs at this mine, with account of methods used. Ills. 2000 w. Min & Engng Wld—June 15, 1912. No. 33753.

Placers

Placer Mining in the Province of Quebec. H. A. Ball. Brief review of the history of these placers, the present condition and the outlook. 1800 w. Min & Sci Pr—May 25, 1912. No. 33301.

Refractory Ores

Refractory Manganese-Silver Ores. Will H. Coghill. Report of extensive investigations of an eccentric ore. 3000 w. Min & Sci Pr—June 1, 1912. Serial. 1st part. No. 33476.

Transvaal

Transvaal Gold Mining—Present and Future Methods. F. H. Hatch. A summary of conditions and estimate of the life of the Rand. Ills. 5500 w. Engineering Magazine—July, 1912. No. 33962 B.

Victoria

North Nuggety Ajax Mine, Doylesford (V.). Victor Pabst. Describes the location and development of this gold field and its peculiarities. 1800 w. Aust Min Stand—May 2, 1912. No. 33444 B.

IRON AND STEEL**Asphyxiation**

Asphyxiation by Blast-Furnace Gases. From *Ann. des Mines de Belgique*. Information concerning such accidents, the precautions that should be taken especially when gas mains are being cleaned. Ills. 2500 w. Ir & Coal Trds Rev—May 17, 1912. No. 33283 A.

Blast-Furnace Practice

The Upward Concentration of Kish by Flotation. Henry M. Howe. Investigates the concentration of graphite in the upper part of a casting, giving opinions of other investigators, and the author's conclusions. Ills. 1200 w. Met & Chem Engng—June, 1912. No. 33416 C.

Blast-Furnaces

Recent American Blast-Furnace Plants (Neuere Amerikanische Hochofenanlagen). H. Groeck. Description of some of the late furnaces erected in the United States. Ills. 5300 w. Zeitschr d Ver deutscher Ing—May 25, 1912. No. 33576 D.

Blowers

The Efficiency of Small Blowers. P. J. Haler and H. T. Wright. Gives brief descriptions of the Roots blower, a Crowell blower, and a rotary positive blower. Ills. 700 w. Prac Engr—June 14, 1912. Serial. 1st part. No. 33925 A.

See also Turbo-Blowers, under MECHANICAL ENGINEERING, *Power and Transmission*.

Brazil

The Iron Resources of Brazil. John Brooks Elgar. An illustrated article discussing the possibilities of vast deposits and their influence upon possible commercial relations with the United States. 2500 w. Cassier's Mag—June, 1912. No. 33846 B.

Electrometallurgy

Heat-Treatment of Steel by the Electric Furnace. H. Ralph Badger. Explains the advantages of electric heating for

hardening steel, the application and importance. Ills. 3000 w. Mach, N Y—June, 1912. No. 33352 C.

✓ The Electric Furnace in Steel Manufacture. William R. Walker. Read before the Am. Ir. & St. Inst. Discusses the possibilities of producing an improved quality of steel. 4500 w. Ir Trd Rev—May 30, 1912. No. 33329.

Michigan

The Iron Ranges of Michigan. P. B. McDonald. Information concerning the value, the ore reserves, and related matters. Ills. 1000 w. Min & Sci Pr—June 22, 1912. No. 34097.

Iron Ore Reserves of Michigan. C. K. Leith. From advance chapters of Min. Resources of the U. S., 1911. Summary of estimates in report of the State Board of Tax Commissioners. Map. 2200 w. Min & Sci Pr—June 8, 1912. No. 33692.

Ontario

The Eastern Michipicoten Iron Range. Alois Goetz. Notes based on memoranda taken while prospecting on this range in Canada, describing the properties. 3000 w. Eng & Min Jour—June 1, 1912. No. 33344.

Open-Hearth Furnaces

New Open-Hearth Furnace Designs. Herbert F. Miller, Jr. Illustrated account of how experiments led to changes in combustion arrangements. 1500 w. Ir Age—June 27, 1912. No. 33986 C.

An Open-Hearth Furnace of a Detachable Type. Illustrated description of the Carr detachable open-hearth furnace in the plant of the Alloy Steel Casting Co., Wheeling, W. Va. 4000 w. Ir Trd Rev—June 20, 1912. No. 33865.

Open-Hearth Furnace of a Detachable Type. The Carr furnace is illustrated and described. 4500 w. Foundry—June, 1912. No. 33410.

Rolling Mills

Electric Reversible Rolling Mills and Auxiliary Equipment. Brief illustrated description of an interesting plant in Austria. 1200 w. Sci Am Sup—June 15, 1912. No. 33717.

Cambria Steel Co.'s Motor-Driven Merchant Mills. Illustrates and describes a successful installation of electrically-operated steel rolling equipment. 2200 w. Ir Trd Rev—May 30, 1912. No. 33327.

Steel Works

Recent Developments in Steel-Works Practice. B. W. Head. Read before the W. of Scotland Iron & Steel Inst. Considers the better utilization of waste gases, recent developments in the open-hearth process, the Talbot process, furnaces, etc. Ills. 4000 w. Ir & Coal Trds Rev—May 17, 1912. Serial. 1st part. No. 33281 A.

Arizona**LEAD AND ZINC**

The Castle Dome Lead District, Arizona. J. Nelson Nevins. Illustrated de-

scription of the district and its mines. 1800 w. *Min & Sci Pr*—June 22, 1912. No. 34096.

Concentrating

Small Concentrating Mills in the Wisconsin Zinc District. W. F. Boericke. An account of methods and costs. 3500 w. *Min & Sci Pr*—June 15, 1912. No. 33849.

Nevada

Zinc Mines of Southern Nevada. Douglas White. Describes the Yellow Pine district, the ores and costs of mining and shipping. 4500 w. *Mines & Min*—June, 1912. No. 33364 C.

Oklahoma

The Miami Zinc-Lead District, Oklahoma. Temple Chapman. Gives map showing parallel runs of ore, describing the deposits. 1200 w. *Eng & Min Jour*—June 8, 1912. No. 33617.

Smelting

The Origin of Zinc Smelting. W. Hommel. Gives the history of the art which originated in India and was extensively practiced in China at an early period. Ills. 3500 w. *Eng & Min Jour*—June 15, 1912. No. 33733.

MINING

Accidents

Mine Accidents and Their Prevention. Ed. Ryan. Address before the Engrs.' Club, Mackay Sch. of Mines. Explains some of the dangers and the means for protecting the workers. 4500 w. *Min & Sci Pr*—June 22, 1912. No. 34098.

Blasting

Suggestions in Loading and Firing Well Drill Blast Holes. From a paper by S. R. Russell before the Nat. Lime Mfrs.' Assn. Gives records of loading and firing well drill holes in quarry work. 2500 w. *Engng & Con*—June 12, 1912. No. 33700.

Electric Priming in Shaft Sinking (Die elektrische Zündung beim Schachtabteufen). Herr Lisse. Descriptive of proper arrangement of wires and a new apparatus for assuring the explosion of all charges. Ills. 1400 w. *Glückauf*—May 11, 1912. No. 33514 D.

Crosscuts

A Problem in Deep-Mine Exploration by Crosscut. Carl Henrich. Shows that the cost per foot is less for a large than for a small size crosscut. 2000 w. *Engng & Min Wld*—June 1, 1912. No. 33395.

Dredging

Reducing California Dredging Costs. Al. H. Martin. Explains economies resulting from the use of dredges having buckets of larger capacity. 1500 w. *Mines & Min*—June, 1912. No. 33366 C.

Drills

A Comparison Between Portable Electric Drills and Portable Air Drills. A. G. Popcke. Ills. 800 w. *Elec Jour*—June, 1912. No. 34042.

See also same heading, under **MECHANICAL ENGINEERING, Machine Works and Foundries.**

Electric Power

Electrical Operation of Limestone Quarries and Crusher Plants. P. N. Harrison. Illustrated article describing the routine of operations, and giving actual records. 3000 w. *Elec Jour*—June, 1912. No. 34037.

Electricity in Mines (L'électricité dans les mines). H. Marchand. Review of power plants, and power utilization in mining machinery. Ills. Serial. 1st part. 2400 w. *L'Électricien*—June 8, 1912. No. 33594 D.

See also Hoists, under *Mining*.

Filling

Hydraulic Filling in European Mines. L. Bucherer. An account of the dry filling method formerly used in Silesia and the hydraulic methods now used. Ills. 3000 w. *Mines & Min*—June, 1912. No. 33356 C.

Hoisting Ropes

The Safety of Hoisting Ropes (Der Sicherheit der Förderseile). Herr Speer. Testing methods and tables giving safe and ultimate loads for ropes and cables of various sizes and qualities. Ills. Serial. 1st part. 7500 w. *Glückauf*—May 11, 1912. No. 33513 D.

Hoists

The Electric Mine Hoist as a Power Station Load. F. L. Stone. Discusses methods of keeping the peaks from the line. 2500 w. *Gen Elec Rev*—June, 1912. No. 33382 C.

Laws

Revision of the Mining Laws. F. J. H. Merrill. Considers the four important questions given in a letter issued to the members of the Min. & Met. Soc. of Am. by the Committee on Mining Laws. 2000 w. *Min & Sci Pr*—June 1, 1912. No. 33477.

Methods

Block Caving and Sub-stoping. Illustrates and describes systems employed at Tobin mine, Mich., to meet special conditions. 1000 w. *Mines & Min*—June, 1912. No. 33365 C.

The Sublevel Stopping Method. F. W. Speer. Detailed description of this method, used with advantage for small deposits. Ills. 2000 w. *Eng & Min Jour*—June 15, 1912. No. 33732.

Mine Timber

See Timber, under **CIVIL ENGINEERING, Materials of Construction.**

Ore Bins

Joplin Ore Bin Construction. Illustrates and describes types used. 1200 w. *Eng & Min Jour*—June 22, 1912. No. 33889.

Ore-Reserves

A Concise Method of Showing Ore-Reserves. N. H. Emmons. Explains a method of measuring up ore in sight. General discussion. 2000 w. *Bul Am Inst of Min Engrs*—June, 1912. No. 34049 F.

Prospecting

Considerations Before Opening Mines. Arthur J. Hoskin. Brief discussion of legal matters, topography, transportation, climate, labor, supplies, extent of property. 3000 w. Mines & Min—June, 1912. No. 33368 C.

Locating Ore Deposits by Wireless Telegraphy. O. Trüstedt. Trans. from *Zeit. für praktische Geol.* Discusses methods and their applications to prospecting. Also editorial. 2500 w. Min & Engng Wld—June 8, 1912. No. 33636.

Shaft Sinking

Record Sinking at State Mines, Witwatersrand. A. Cooper-Key. An account of the sinking of the southeast shaft, of the Gov. Gold Min. Areas Con., 233 ft. during March. 1800 w. Engng & Min Wld—June 1, 1912. No. 33396.

MINOR MINERALS**Arsenic**

Information on the Arsenic Ore Deposits in Bosnia (Zur Kenntnis der Arsenerzlagerstätten Bosniens). Fr. Katzer. Brief history of these deposits which have been known since the 14th century. Serial. 1st part. 2400 w. Oest Zeit f Berg u Hüttenwesen—May 18, 1912. No. 33510 D.

Cement

See same heading, under **CIVIL ENGINEERING, Materials of Construction.**

Natural Gas

Natural Gas Investigations of the Bureau of Mines. George A. Burrell. Read before the Nat. Gas Assn. Reports progress made in a study of this fuel. 1800 w. Chem Engr—June, 1912. No. 33960 C.

The Fayette Gas Field, Alabama. M. J. Munn. Gives the location and description and discusses possibilities. 1200 w. Min & Engng Wld—June 22, 1912. No. 33897.

Oil

The Occurrence of Oil and Gas Deposits Associated with Quaquaversal Structure. Frederick G. Clapp. Gives results of a study in the Pennsylvania, Ohio, Texas, Louisiana, and Mexico fields. 5000 w. Ec-Geol—June, 1912. No. 34022 D.

Geology of the San Juan County Oil Field, Utah. E. G. Woodruff. Map and description. 1000 w. Min & Engng Wld—June 22, 1912. No. 33898.

Geology of Wyoming's Leading Petroleum Sections. Map, with reports of the different districts. 4000 w. Min & Engng Wld—June 22, 1912. No. 33896.

History and Development of Louisiana's Oil Fields. Paul Wooton. Map, with description of the occurrence, geology, and development. 2500 w. Min & Engng Wld—June 22, 1912. No. 33894.

Illinois Oil Industry; Its History and Development. Raymond S. Blatchley. Map and general review of this district. 2500 w. Min & Engng Wld—June 22, 1912. No. 33893.

The Oilfields of Galicia (Austria). V. Kravani. Explains the development and present position of petroleum mining in this field. 3000 w. Min Jour—June 15, 1912. No. 33923 A.

The Oil Fields of Texas and Their Development. W. D. Hornaday. Map and descriptive account. 1800 w. Min & Engng Wld—June 22, 1912. No. 33895.

Petroleum

History and Geology of California Oil Fields. Paul W. Prutzman. Describes various oil districts, reviewing their history and the geology and present developments. 7000 w. Min & Engng Wld—June 22, 1912. No. 33892.

Growth of the Petroleum Industry in California. William H. Storms. Reviews the history of the development. Map. 2500 w. Min & Engng Wld—June 22, 1912. No. 33891.

Importance of Mexico as a Petroleum Producer. Sectional map showing location of oil wells, with description and report of development. 3500 w. Min & Engng Wld—June 22, 1912. No. 33899.

Saltpetre

The Nitrate of Soda Industry in Chili (L'Industrie du Nitrate de Soude au Chili). B. Diaz-Ossa. Reviews the commercial organization of the industry. 4000 w. Rev Gen des Sciences—May 30, 1912. No. 33598 D.

Tin

An Unusual Zonal Arrangement of Tin Ore in a Vein. Gilmour E. Brown. Describes an unusual deposit in Bolivia. 1500 w. Min Jour—June 15, 1912. No. 33922 A.

Tin Mining in Nigeria. Brief account of its past history as a tin producer, and a discussion of the future outlook. 1500 w. Can Min Jour—June 15, 1912. No. 33854.

Tungsten

Metallic Tungsten and Some of Its Applications. W. D. Coolidge. Information concerning tungsten and its properties, with discussion of some of the new applications. 3000 w. Pro Am Inst of Elec Engrs—June, 1912. No. 34062 F.

ORE DRESSING AND CONCENTRATION Classifiers

A Skaking Inclined-Screen Hydraulic Classifier. Lewis B. Skinner. Part of a paper read before the Colo. Sci. Soc., discussing the Richards pulsator classifier and describing the design of the author. Ills. 2500 w. Met & Chem Engng—June, 1912. No. 33413 C.

Crushers

Types of Shaft Bearings for Gyratory Crushers. Outlines different designers' solutions of this problem. Ills. 1500 w. Engng & Con—May 29, 1912. No. 33303.

Progress in Roll-Crushing. C. Q. Payne. Illustrates and describes the Frazer rolls, and gives an outline of the development of roll-crushers, and their advantages for

coarse and for fine crushing. Discussion. 7500 w. *Bul Am Inst of Min Engrs*—June, 1912. No. 34048 F.

Heavy-Duty Crushing Rolls. S. W. Traylor. Drawings and description of an improved automatic lateral adjustment, showing its importance in fine grinding. 1500 w. *Met & Chem Engng*—June, 1912. No. 33418 C.

Electrostatic Separation

Electrostatic Concentration or Separation of Ores. Henry A. Wentworth. Explains the principle utilized in electrostatic separation and methods of applying. Ills. 5000 w. *Bul Am Inst of Min Engrs*—June, 1912. No. 34051 F.

Jigs

Joplin Hand Jig. Drawings and description of details. 1500 w. *Eng & Min Jour*—June 1, 1912. No. 33341.

Magnetic Concentration

Magnetic Concentration of Iron Ores. Henry Louis. Abstract of lecture before the W. of Scotland Ir. & St. Inst. Considers the magnetic permeability and intensity of magnetization, illustrates and describes various designs of magnetic separators and the design of plants for magnetic separation and concentration. 4000 w. *Ir & Coal Trds Rev*—May 24, 1912. No. 33470 A.

Magnetic Concentration of Ural Ores in Herräng, Sweden (Magnetische Anreicherung von Ural-Erzen in Herräng, Schweden). Description and results from the application of the Gröndal system. Ills. 2400 w. *Stahl u Eisen*—May 16, 1912. No. 33504 D.

Reactions

Mass Action and Reaction Velocity. Harry C. Jones. Discusses the influence of mass on reaction velocity and chemical equilibrium. 3000 w. *Eng & Min Jour*—June 1, 1912. No. 33343.

Refractory Ores

See same heading, under *Gold and Silver*.

Slimes

The James Diagonal-Plane Slimmer. S. Arthur Krom. Illustrated description of the machine and its use. 1500 w. *Bul Am Inst of Min Engrs*—June, 1912. No. 34052 F.

RARE MINERALS

Carnotite

The Concentration of Carnotite Ores, and Some Similar Ores. Siegfried Fischer. Reports tests to prove carnotite a coating on the mother mineral, and gives an outline of the treatment and tests. Ills. 2500 w. *Met & Chem Engng*—June, 1912. No. 33415 C.

Radium

Radium Minerals of Saxony and Their Discovery. C. Schiffner. Abstract of a pamphlet published in 1911. Describes the uranium minerals found. 3000 w. *Min & Engng Wld*—June 15, 1912. No. 33754.

The Origin of Radium. Frederic Soddy. From a discourse at the Roy. Inst. Reports experiments which seem to prove uranium cannot be its immediate parent. 3000 w. *Sci Am Sup*—June 1, 1912. No. 33287.

The Origin of Radium (L'Origine du radium). F. Soddy. Discusses the theory of atomic disintegration. Diagrams. 3600 w. *Rev Gen des Sciences*—May 15, 1912. No. 33595 D.

Turquoise

The Origin of Turquoise in the Burro Mountains, New Mexico. Sidney Paige. Gives known facts and deductions. 3500 w. *Ec-Geol*—June, 1912. No. 34023 D.

Vanadium

Vanadium—Its Ores and Uses. Thomas F. V. Curran. An account of the occurrences and applications. 3000 w. *Eng & Min Jour*—June 1, 1912. No. 33345.

MISCELLANY

Germany

Mineral Production in the Lower Rhine and Westphalian Mining Districts during 1911 (Die Bergwerksproduktion des niederrheinisch-westfälischen Bergbaubezirks im Jahre 1911). Dr. Ernst Jüngst. Review of total production of ores, oils and gases, and comparison with production in 1910. 7500 w. *Glückauf*—May 18, 1912. No. 33517 D.

Mexico

Conditions in Mexico. F. W. Oldfield. Brief description of present conditions in the mining districts since the revolution as observed during a recent visit. Ills. 3000 w. *Min Mag*—June, 1912. No. 33993 B.

Mining Industry

The Relation Between Mining and Civilization. James Ralph Finlay. Abstract of annual commencement address at Missouri Sch. of Mines. On the importance of mining products in the industrial system, their present uses, and the future outlook. 2500 w. *Min & Engng Wld*—June 15, 1912. No. 33752.

New Zealand

Report of New Zealand Royal Commission on Mines. Full abstract of the recently issued report, dealing with accidents, ventilation, sanitation, change houses, phthisis, etc. 5000 w. *Ir & Coal Trds Rev*—May 31, 1912. Serial. 1st part. No. 33680 A.

Ontario

Lake of the Woods Mining District. William J. Richards. An account of the Sultana mine, and the effort to sink a shaft at the bottom of a lake in 18 feet of water. Ills. 1200 w. *Mines & Min*—June, 1912. No. 33361 C.

Ore Deposits

Is Geology a Success as a Guide to Ore Deposits? Walter Harvey Weed. An endeavor to estimate the value of geology in locating ore deposits. 1000 w. *Min &*

Engng Wld—June 1, 1912. Serial. 1st part. No. 33394.

Research Work

Work of the Bureau of Mines. Statement of the work of the U. S. Bureau by Walter L. Fischer. 3000 w. Eng & Min Jour—June 15, 1912. No. 33730.

Washington

The Geology of the St. Helens Mining District of Washington. Carl Zapffe. Gives a summary of the writer's observations of this southern portion of the Cascade Mts. 3500 w. Ec-Geol—June, 1912. No. 34020 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Accidents

F. C. Rice and the American Railway Association on Accidents. A statement of conditions and urging a campaign with the object of reducing accidents. 2500 w. Ry Age Gaz—June 7, 1912. No. 33496.

Collisions

Report on Hoosac Tunnel Collision. Gives facts brought out in the report of Prof. William L. Puffer, who made an examination of the electrical conditions at the tunnel. 2500 w. Ry Age Gaz—June 21, 1912. No. 33874.

Long Runs

Long Non-Stop Runs on Railways. Dr. A. Kuntzemüller. Examines in detail the conditions necessary and compares the records of other countries with Germany. 5400 w. Bul Int Ry Cong—June, 1912. No. 33997 G.

Signaling

Railway Signaling. C. E. Denney. Explains the reason for signals on a railroad, and illustrates and describes types of block signals. General discussion. 4500 w. Jour Cleveland Engng Soc—June, 1912. No. 34056 D.

Railway Signaling. Condensed article by Thomas S. Stevens, in the *Santa Fe Employees' Mag.* Explains the purposes for which signals are used. The present number reviews the past history of interlocking signals. 1600 w. Ry & Loc Engng—June, 1912. Serial. 1st part. No. 33401 C.

The Indications of Railway Fixed Signals. C. C. Anthony. A detailed explanation of fixed signals and their use. Ills. 4000 w. Sib Jour of Engng—June, 1912. No. 34027 C.

Double-Wire Transmissions for Operating Switches and Signals on the Belgian State Railway. J. Verdegen. Ills. 2500 w. Bul Int Ry Cong—May, 1912. No. 33684 G.

New Signal Equipment on the Indianapolis & Cincinnati Road. Illustrated description of an installation of manually operated, remotely controlled car signals. 3000 w. Elec Ry Jour—June 8, 1912. No. 33628.

Train Control

Wireless Train Control. Frank Wyatt Prentice. Tells the story of the develop-

ment of this idea. Discussion. 15000 w. Pro Cent Ry Club—May 10, 1912. No. 33810 C.

MOTIVE POWER AND EQUIPMENT

Boiler Efficiency

Locomotive Boiler Flue Gas Analysis. Sanford H. Fry. Gives a simple method of finding the weight of the gases and of dividing the boiler efficiency into its component parts. 3000 w. Ry Age Gaz—July 5, 1912. No. 34256.

Boiler Tests

Low Water Locomotive Boiler Tests. An outline of the bursting tests and the results both expected and unexpected. Ills. 2000 w. Ry Age Gaz—June 28, 1912. No. 34123.

Brakes

Automatic Brake Slack Adjusters for Steam and Electric Cars. W. H. Sauvage. Shows the destruction to rolling stock due to poorly adjusted brakes and the requirement of an automatic slack adjusted to take up the brake shoe wear. Also discussion. Ills. 10000 w. Pro N Y R R Club—May 17, 1912. No. 33809.

Car Heating

Alcohol Heater Car. Illustrated description of a car designed to furnish protection from freezing of perishable products. 800 w. Ry Age Gaz—June 7, 1912. No. 33499.

Cars

High-Capacity Railway Wagons. Herbert Kelway-Bamber. Notes on the relation of wheel diameter to tractive effort, etc. 1000 w. Engng—May 24, 1912. No. 33460 A.

A New Type of Steel Passenger Car. Illustrates and describes details of the suburban cars of the New York, Westchester & Boston, embodying a simplified steel body frame. 1500 w. Ry Age Gaz—June 14, 1912. No. 33711.

Central of New Jersey Ice Car. Illustrated description of cars designed to meet the requirements. 700 w. Ry Age Gaz—June 7, 1912. No. 33497.

New Pullman Buffet Car, South-Eastern and Chatham Railway. Views and description of fine cars recently put in service in England. 1200 w. Ry Gaz, Lond—May 17, 1912. No. 33265 A.

The Erie Track Inspection Car. E. G. Chenoweth. Illustrated description of the car and its equipment. 1500 w. Ry Age Gaz—June 21, 1912. No. 33875.

Driving Boxes

Repairing Locomotive Driving Boxes. E. T. Spidy. Prize paper. Illustrated detailed description of the methods used at the Winnipeg shops of the Canadian Pacific. Also editorial. 2500 w. Am Engr—June, 1912. No. 33604 C.

Repairing Driving Boxes. M. H. Westbrook. Describes methods suited for a shop operating 15 or more pits. Ills. 1500 w. Am Engr—July, 1912. No. 34265 C.

Locomotive Explosion

San Antonio Locomotive Explosion. Abstract of a report by John F. Ensign to the Interstate Commerce Commission. An interesting report, fixing the blame. Also editorial note. 2500 w. Power—June 4, 1912. No. 33421.

Statement of Mr. Fay on San Antonio Boiler Explosion. Analysis of the evidence brought out by the Railway Company's inquiry. 3500 w. Ry Age Gaz—June 21, 1912. No. 33873.

Locomotive Fire-Boxes

The Staying of Fire-Boxes. Robert Weatherburn. Discusses the mechanical applications to staying, and the causes, actions and results which are termed wear and tear. 2200 w. Engr, Lond—May 17, 1912. Serial. 1st part. No. 33274 A.

Locomotive Flue Gas

The Utility of Flue Gas Analyses in Locomotive Testing. Sanford H. Fry. An examination of tests made by Dr. W. F. M. Goss, showing the value of flue gas analyses by application to these tests. 2000 w. Ry Age Gaz—June 21, 1912. No. 33870.

Locomotive Fuels

Fuel as a Factor in Locomotive Capacity. W. F. M. Goss. Read before the Int. Ry. Fuel Assn. On the importance of larger grate areas in locomotive practice. 2500 w. Ry & Engng Rev—June 1, 1912. No. 33390.

International Railway Fuel Association. Gives abstracts of papers presented at the recent convention in Chicago. 13500 w. Ry Age Gaz—May 31, 1912. No. 33338.

International Railway Fuel Association. Report of the Chicago meeting, with abstracts of papers and discussions. 21000 w. Am Engr—June, 1912. No. 33607 C.

Locomotive Fuel Economy. Ernest Cordeau. Considers points where considerable savings have been effected. 3000 w. Ry Mas Mech—June, 1912. No. 33746 C.

Locomotive Drafting and Its Relation to Fuel Consumption. H. B. MacFarland. Extracts from a paper read before the Int. Ry. Fuel Assn. Gives results of extensive experiments, discusses details, and criticises present practice. Diagrams. 11500 w. Ry & Engng Rev—June 8, 1912. No. 33637.

Investigations into the Application of Petroleum Products for Locomotive Driv-

ing (Die Herstellung und Untersuchung der im Eisenbahnbetrieb verwendeten Petroleumprodukte). L. Weinstein. Discussion on the kinds of oil available as fuel for railway work. 3000 w. Glaser's Ann—May 15, 1912. No. 33525 D.

See also Locomotives, under *Motive Power and Equipment*.

Locomotives

Oil Burning Locomotives. Illustrates and describes standard practices of the leading roads using fuel oil, giving data and results. 5000 w. Ry Mas Mech—June, 1912. Serial. 1st part. No. 33744 C.

"Baltic" Type Locomotives—Northern Railway of France. Illustration, drawings and description of the largest and most powerful express passenger locomotives in Europe. 1000 w. Ry Gaz, Lond—June 7, 1912. No. 33776 A.

4-6-2 Type of Locomotive, for the Central of Georgia Railway. Illustrated description of a Pacific type of locomotive. 900 w. Ry & Loc Engng—June, 1912. No. 33399 C.

Six-Coupled Express Passenger Engine, Great Eastern Railway. Plate, illustrations, and dimensions. 300 w. Engr, Lond—June 14, 1912. No. 33945 A.

Simple Freight Locomotives for the Virginian. Illustrated description. 600 w. Ry Age Gaz—July 5, 1912. No. 34258.

Maintaining Mallet Locomotives. A report of New York Central & Hudson River practice. 2000 w. Am Engr—July, 1912. No. 34261 C.

Simple Mallet for High Speed. G. I. Evans. Illustrates and describes an articulated locomotive with four equal size cylinders grouped at the center of the wheel base and designed for speeds up to 50 miles per hour. 2500 w. Am Engr—July, 1912. No. 34262 C.

Type of Mallet Articulated for the Lake Terminal Railroad. Illustrated description of an engine designed to push trains of loaded cars from the docks at Lorain, Ohio. 800 w. Ry & Loc Engng—July, 1912. No. 34194 C.

Mallet Articulated Locomotive for St. Louis, Iron Mountain & Southern Ry. Illustrated detailed description. 1000 w. Ry & Engng Rev—June 15, 1912. No. 33755.

Powerful Mallet Compound Locomotive for the Virginian Ry. Drawings and description. 1000 w. Ry & Engng Rev—June 22, 1912. No. 33902.

The Most Powerful Locomotive. Illustrates and describes the Mallets of the Virginian Ry. 800 w. Am Engr—June, 1912. No. 33606 C.

Mikado and Pacific Type Locomotives for the Buffalo, Rochester & Pittsburg Ry. Illustrated comparison of new locomotives with those they have replaced. 1000 w. Ry & Engng Rev—June 1, 1912. No. 33389.

Performance of Mikado Type Locomotive, Chesapeake & Ohio Ry. Illustrated description with report of tests. 1200 w. Ry & Engng Rev—June 22, 1912. No. 33903.

Locomotive Stokers

Present Status of Mechanical Stokers for Locomotives. A portion of the report of the Committee to the American Ry. Master Mech's Assn. Reviews the stokers in service and describes new stokers under process of development. 3500 w. Eng News—June 27, 1912. No. 34114.

Locomotive Tests

Tests on Compound, Superheater, Pacific Locomotives of the Compagnie d'Orléans (Essais des Locomotives Pacific Compound a Surchauffe de la Compagnie d'Orléans). Paul Conté. Gives results of a series of tests, describing locomotives, and giving diagrams and tables. 5000 w. Rev Gen des Chemins de Fer—June, 1912. No. 33597 G.

Storekeeping

Fundamental Principles of Railway Storekeeping. George G. Yeomans. An argument for departmental organization. 2500 w. Ry Age Gaz—June 21, 1912. No. 33871.

Superheaters

The Development of the Superheater in Locomotives. Illustrates and describes the mechanical construction of the Schmidt superheater, reviewing its development. 1500 w. Ry & Loc Engng—June, 1912. No. 33398 C.

Locomotive Superheaters. S. G. Winn. First article of a series discussing in detail the principles and the types of superheaters for locomotives. 1500 w. Mech Wld—May 24, 1912. Serial. 1st part. No. 33456 A.

Superheated Steam in Locomotive Service. W. F. M. Goss. A review of publication No. 127 of the Carnegie Inst. of Washington. Gives results of a study of recent German practice in the use of superheated steam, and results of tests made on an American Locomotive. Ills. 66 pages. Univ of Ill, Bul 57—April 22, 1912. No. 33808 N.

See also Locomotive Tests, under *Motive Power and Equipment*; and Superheaters, under MECHANICAL ENGINEERING, *Steam Engineering*.

Switch Engines

The New Switch Engines of the Prusso-Hessian Railway System (Die neue Verschiebelokomotive der preussisch-hessischen Staatseisenbahnverwaltung). Herr Bergerhoff. Description of this new type. Ills. and plate. 1200 w. Zeitschr d Ver deutscher Ing—May 4, 1912. No. 33569 D.

Train Lighting

Introduction and Development of Electric Train Lighting on the Former Kaiser Ferdinands-Nordbahn (Einführung und Entwicklung der elektrischen Zugbeleuchtung bei der ehemaligen Kaiser Ferdi-

nands-Nordbahn). F. Bach. Description of the various systems employed at different times, batteries, accumulators, dynamos, etc. Ills. 5600 w. Elek u Masch—May 26, 1912. No. 33538 D.

Train Resistance

The Effect of Cold Weather Upon Train Resistance and Tonnage Rating. Edward C. Schmidt and F. W. Marquis. Gives results of tests made to determine the increase in the resistance of freight trains during cold weather. 24 pages. Univ of Ill, Bul 59—May 27, 1912. No. 33948 N.

Wheels

The Impact of Flat Wheels Upon Rails. C. H. Benjamin. Remarks on the failures of steel rails, and the investigations to be made to determine the laws of impact under different conditions. 1200 w. Ry Age Gaz—June 28, 1912. No. 34126.

NEW PROJECTS

Bagdad Railway

The Bagdad Railway and Why It is of Interest to the United States. Albert Gleaves. Discusses the effect of this railway connecting Constantinople with the Persian Gulf, upon German emigration, and upon trade relations, etc. Map. 6500 w. Pro U S Nav Inst—June, 1912. No. 33973 E.

Canada

Construction of the New Lines of the Algoma Central & Hudson Bay Railway. R. S. McCormick. Describes railway building toward Hudson Bay from the Sault across three transcontinental roads. Maps. 3500 w. Eng Rec—June 8, 1912. No. 33625.

Canadian Transcontinental Railway. Map and illustrated description of the construction work and its difficulties, with some economic considerations. 9000 w. Eng News—June 27, 1912. No. 34110.

Cut-Off

Harriman Lines Spokane-Ayer Cut-Off. Map and illustrated description of heavy construction work on the new line of the Oregon-Washington R. R. & Nav. Co. 3000 w. Ry Age Gaz—May 31, 1912. No. 33337.

East Indies

The Proposed Government Railway in the Dutch East Indies, and the Railway Plans for South Sumatra (Eenige mededeelingen over den aanleg van Staats-spoorwegen in Ned. Oost-Indië en over het spoorwegplan in Zuid-Sumatra). R. P. O. D. Wijnmalen. Description of proposed routes. Ills. and map. 11800 w. De Ingenieur—May 25, 1912. No. 33585 D.

Extensions

Two Railway Extensions in Ontario. R. S. McCormick. Gives the history and construction details of the completion of the Algoma Central & Hudson Bay and the Algoma Eastern. Ills. 3000 w. Ry Age Gaz—July 5, 1912. No. 34254.

Panama

The Panama Railroad. Percy F. Martin. A detailed description of its efficient reconstruction and maintenance, and review of its history. 3000 w. Engr, Lond—June 14, 1912. Serial. 1st part. No. 33943 A.

South Africa

The Benguela Railway. A Shortened Route to the Transvaal. J. Hartley Knight. Map and illustrated description of engineering construction under unusual conditions. 1800 w. Engineering Magazine—July, 1912. No. 33966 B.

Switzerland

New Lines of the Rhätian Railway, Ilanz to Disentis and Bevers to Schuls (De neuen Linien der Rhätischen Bahn, Ilanz-Disentis und Bevers-Schuls). S. Saluz. Describes projected continuations from main lines at Davos, running east and west. First part considers the Ilanz-Disentis line. Ills. Serial. 1st part. 2900 w. Schweiz Bau—April 20, 1912. No. 32714 D.

See also Suspension, under CIVIL ENGINEERING, *Bridges*.

Tripoli

A Railway in Tripoli. An illustrated account of the construction of a railway in Tripoli by the Italians. 2500 w. Engr, Lond—May 24, 1912. No. 33468 A.

Railways in Libya and Contiguous Regions (Le ferrovie nelle Libia e nelle regioni contigue). F. Agnello. Reviews construction difficulties under desert conditions, and economic problems. Maps. 2700 w. Ann della Soc d Ing e d Arch Ital—May 1, 1912. No. 34009 E.

PERMANENT WAY AND BUILDINGS**Electric Power**

The Use of Electricity on Railways. E. M. Herr. Abstract of an address at the dinner of the Am. Ry. Guild, N. Y., May 14, 1912. Discusses its future application to transportation, particularly through the development of large central power stations. 2500 w. Ry Age Gaz—July 5, 1912. No. 34257.

The Use of Electric Power for Starting Machine Engines in Stations, Depots, Shops, etc. (Quelques Réflexions sur l'Emploi de l'Energie Electrique pour la Mise en Action des Engines Mécaniques dans les Gares, les Dépôts, les Ateliers, etc). Notes on the power consumption for this work. Diagrams. 3300 w. Rev Gen des Chemins de Fer—May, 1912. No. 32756 G.

Embankments

Two Methods of Constructing Railway Embankment Over Soft Ground. Describes the embankment across Muskegs, Canada, and the embankment across Panama swamps, as illustrating the two methods. Ills. 700 w. Engng & Con—June 12, 1912. No. 33705.

Line Revision

Extensions and Improvements, Canadian Northern Ry. Map and illustrated description of work on this road. 1500 w. Ry & Engng Rev—June 1, 1912. No. 33388.

Terminals

Berlin Terminus Stations and Their Traffic Capacity. Dr. Schroeder. Discusses the factors affecting traffic capacity and how it is possible to obtain better results. 5000 w. Bul Int Ry Cong—June, 1912. No. 33996 G.

Locomotive Terminals on the Chicago & Northwestern Ry. Illustrated detailed descriptions of a series of new terminals at various points. 4000 w. Ry & Engng Rev—June 15, 1912. No. 33756.

See also same heading, under ELECTRICAL ENGINEERING, *Power Applications*.

Track

The Formation, Nature, Importance and Utility of the Osnabrücker Track Exhibition (Ueber Entstehung, Wesen, Bedeutung und Nutzbarmachung der Osnabrücker Gleissammlung). Herr Haarmann. Illustrated description of old and modern track methods, including rail designs, and ties of all the latest approved standards. 7000 w. Glaser's Ann—April 15, 1912. No. 32709 D.

Widening

The Euston and Watford Widening. Illustrated description of important work on the London & Northwestern in England. 1500 w. Ry Gaz, Lond—June 14, 1912. No. 33924 A.

The Euston to Watford Widening. Map and illustrated description of work on the London & Northwestern Railway. 3500 w. Engr, Lond—June 14, 1912. No. 33942 A.

TRAFFIC**France**

Review of Traffic Questions. C. Colson. Reviews the results of working the railways of the French State from 1909 to 1911. 7300 w. Bul Int Ry Cong—May, 1912. No. 33685 G.

Freight

Improvements in the Freight Traffic on the Government Railways (Die Verbesserung des Güterverkehrs auf den k. k. Staatsbahnen). Rudolph Heine. Reviews former and present conditions in Germany. 3000 w. Zeit d Oest Ing u Arch Ver—May 17, 1912. No. 33565 D.

Freight Agents

The Local Freight Agent—His Duties and Responsibilities. R. O. Wells. Paper and general discussion. 14500 w. Pro St Louis Ry Club—May 10, 1912. No. 33644.

Perishable Goods

On the Question of Perishable Goods. J. M. Culp. Addenda to Report No. 1 for countries using the English language. Ills. 7700 w. Bul Int Ry Cong—May, 1912. No. 33683 G.

Sectional Discussion on Perishable Goods at Meeting Held July 11, 1910. 11800 w. Bul Int Ry Cong—May, 1912. No. 33682 G.

Rates

The Tap Line Case Supplemental Report. Gives two cases cited and the commission's general remarks. 3500 w. Ry Age Gaz—June 7, 1912. No. 33498.

MISCELLANY

Australia

Australian Railways. J. G. Jenkins. A detailed review of the conditions, the railways, their administration, etc. General

discussion. 2500 w. Jour Soc of Arts—June 7, 1912. No. 33763 A.

India

Indian Railways. Neville Priestley. Deals with the practical side of the subject, especially with railway finance. Also discussion. 1200 w. Jour Soc of Arts—May 31, 1912. No. 33654 A.

Management

Acworth and Cook on a Government Holding Company. A discussion concerning the managing of a railway system. 3000 w. Ry Age Gaz—June 21, 1912. No. 33869.

STREET AND ELECTRIC RAILWAYS

Accumulator Traction

Accumulator Traction and the Edison Storage Battery, Past, Present and Future. Raymond J. Mitchell. Explains what has been accomplished and the future outlook. 2200 w. Tram & Ry Wld—June 13, 1912. No. 33984 B.

Associations

Technical Papers at the Cedar Point Meeting. The subjects discussed by various authors include the analysis of interurban traffic with relation to time tables, box frame versus split frame railway motors, publicity, transmission lines, standardization, etc. 6500 w. Elec Ry Jour—June 15, 1912. No. 33749.

Austria

Electric Railways (Elektrische Bahnen). A general review of the electric railway systems of Austria-Hungary, routes and equipment. Ills., maps and diagrams. 5000 w. Elek Kraft u Bahnen—May 24, 1912. No. 33534 D.

See also Electrification, under STREET AND ELECTRIC RAILWAYS.

Cars

The Brooklyn Center Entrance Car. Illustrated description of an all-steel, low-step car for prepayment operation. 3500 w. Elec Ry Jour—June 22, 1912. No. 33911.

Chicago

Electrical Transmission and Distribution on Chicago Traction Lines. Gives studies of feeder requirements for return circuits, results of tests, etc., as reported by the Board of Supervising Engineers. 2500 w. Elec Ry Jour—June 22, 1912. No. 33912.

Electric Traction

Intermittency: Its Effect in Limiting Electric Traction for City and Suburban Passenger Transport. William Yorath Lewis. Shows that intermittency has brought existing underground electric railways almost to the limit of their capacity, and suggests a "continuous" system. Also discussion. 12500 w. Soc of Engrs—May 6, 1912. No. 33660 N.

Electrification

The Electrification of Main Line Railroads. William J. Clark. A general statement of the things electric traction has accomplished, and their bearing upon the electrification of main lines. Discussion. 9000 w. Jour Fr Inst—June, 1912. No. 34026 D.

Electrical Equipment of the Austrian State Railways. Illustrates and describes the generating, distribution, and rolling stock equipment for single-phase operation at 25 cycles. 3500 w. Elec Wld—June 8, 1912. No. 33610.

The 1,000-Volt D. C. Electrification of the Budapest Local Railways, Hungary. Julius de Fischer. Illustrated description of this extensive high-tension direct-current electrification which shows many novelties. 6000 w. Elec Ry Jour—June 1, 1912. No. 33392.

Feeders

Feeder Calculations for Return Currents in Electric Railway Systems (Note sur le calcul des feeders de retour du courant dans un réseau de tramways électriques). M. Popliment. Mathematical discussion on line design. Ills. 3800 w. All Industrielle—June, 1912. No. 34000 D.

France

The Electric Railway from Villefranche to Bourg-Madame (Le Chemin de Fer Électrique de Villefranche à Bourg-Madame). Description of details in line construction, and the hydro-electric plant. Ills and plates. Serial. 1st part. 5500 w. Génie Civil—May 4, 1912. No. 32779 D.

Germany

Germany's Elevated and Underground Railways (Deutschlands Hoch- und Untergrundbahnen). Fritz Steiner. A review of these systems in Germany. Ills. and maps. Serial. 1st part. 3700 w. Zeit d Oest Ing u Arch Ver—May 3, 1912. No. 33563 D.

Locomotives

The Highest Voltage Direct Current Locomotive Ever Built in the United States. Illustrated description of a 1500-

volt d. c. locomotive for the Piedmont Traction Co. 700 w. Ry & Loc Engng—June, 1912. No. 33402 C.

Eight-Motor Articulated Electric Locomotive. Illustrates and describes new engines for the N. Y., N. H., & H. R. R. 1800 w. Ry Age Gaz—June 28, 1912. No. 34125.

Articulated Electric Locomotives with Eight Motors. Illustrated description of electric locomotives for the N. Y., N. H. & H. R. R. 1000 w. Am Engr—July, 1912. No. 34264 C.

Motor Cars

•Benzol-Electric Railway Motor Cars (Benzolelektrische Eisenbahn-Motorwagen). A. Heller. Description of a new type of passenger car on the Prussian Railway, with motor drive; power furnished from a six-cylinder engine. Ills. and plates. 4900 w. Zeitschr des Ver deutscher Ing—April 27, 1912. No. 32724 D.

New York, Westchester & Boston

The New York, Westchester & Boston. Gilbert G. Browne. Map and illustrated description of the construction of this new high speed electric line running north from New York City. Also editorial. 3500 w. Ry Age Gaz—June 7, 1912. No. 33495.

Track and Stations of the New York, Westchester & Boston Railway. Illustrated description of the permanent way and structures on this new suburban railway. 2500 w. Elec Ry Jour—June 8, 1912. No. 33627.

Energy Distribution on the New York, Westchester & Boston Railway. Illustrated description of the overhead line construction on this single-phase suburban railway. 3500 w. Elec Ry Jour—June 15, 1912. No. 33748.

Railless

A Review of Railless Electric Traction in England. R. E. Neale. Ills. 2000 w. So Elect'n—June, 1912. No. 33404.

Rates

Street Railway Rates in European and American Cities (Die Fahrpreise der Stadtschnellbahnen in den europäischen und amerikanischen Grossstädten). D. G. Kemmann. General discussion on the rate question, and comparative figures. Serial. 1st part. 5000 w. Elek Kraft u Bahnen—May 14, 1912. No. 33532 D.

Rectifier

An Electric Locomotive with the Auvert Ferrand Rectifier. Description translated from *Le Génie Civil*. Claims flexibility of control and working, and high efficiency. 1200 w. Elec Rev, Lond—May 24, 1912. No. 33446 A.

Subways

New York City Subway Planning. Information concerning the proposed new rapid transit lines, the terms of construction and operating contracts. Map. 4000 w. Eng News—May 30, 1912. No. 33326.

Water Invasion in the Construction Galleries and Driving Galleries of the Berlin Electric Subway (Der Wassereinbruch in die Bau- und Betriebsstrecken der Berliner elektrischen Untergrundbahnen). P. Liez. Description of breaking through of the Spree River, and the methods employed for drainage. Ills. 1000 w. Zeit d Oest Ing u Arch Vereines—April 12, 1912. No. 32725 D.

Swansea

Steam and Electric Traction at Swansea. Illustrated review of the history and development of tramways in Wales. 2500 w. Tram & Ry Wld—June 13, 1912. No. 33983 B.

Switzerland

The Bernina Electric Railway (Le Chemin de Fer Électrique de la Bernina). A. Le Vergnier. Illustrated description of route. 2400 w. Génie Civil—June 8, 1912. No. 34007 D.

The Bernina Electric Railway (La Ferrovia a Trazione Elettrica del Bernina). Description of the hydro-electric plant, equipment, and details in construction of roadway and overhead system. Ills. Serial. 1st part. 4500 w. Ingeg Ferro—April 15, 1912. No. 32790 E.

The Electric and Rack Railway from Blonay to the Pleiades out of Vevey (Le Chemin de fer électrique et à crémaillère Blonay-les Pleiades sur Vevey). V. Ryncki. Description of interesting features in construction. Ills. Serial. 1st part. 1500 w. Bul Tech de l Suisse Romande—April 25, 1912. No. 32763 D.

Systems

The Choice of Current Systems for Electric Railways (Die Wahl des Stromsystems für elektrische Bahnen). O. C. Roedder. Comparison of the relative advantages and costs of different systems. 5000 w. Elektrotech u Maschinenbau—May 12, 1912. No. 33536 D.

Terminals

Coney Island Terminal of the Coney Island and Brooklyn Railroad. Illustrated description of a combination terminal and amusement pavilion at this popular resort. 1200 w. Elec Ry Jour—May 11, 1912. No. 32816.

Train

The Mechanics of Electric Train Movement. F. W. Carter. Abstract of paper before the Manchester Sec. of the I. E. E. Describes a simple method for the calculation of train characteristics and energy consumption. 2500 w. Elect'n, Lond—April 26, 1912. No. 32829 A.

Vienna

Notes on the Solution of Vienna's Traffic Problems (Ein Beitrag zur Lösung des Wiener Verkehrsproblems). Richard Ferge. Proposals for utilizing the present roads by extensions and improvements, rather than subways. Maps. 2000 w. Zeit d Oest Ing u Arch Ver—May 24, 1912. No. 33566 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; H, of \$1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or \$1.00 a year; to non-subscribers, 25 cents per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

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|---|--|
| Alliance Industrielle. <i>m</i> . Brussels. | Bulletin of Dept. of Labor. <i>b-m</i> . Washington. |
| American Architects. <i>w</i> . New York. | Bull. of Can. Min. Inst. <i>qr</i> . Montreal. |
| American Jl. of Science. <i>m</i> . New Haven, U. S. A. | Bull. Soc. Int. d'Electriciens. <i>m</i> . Paris. |
| American Machinist. <i>w</i> . New York. | Bulletin of the Univ. of Wis., Madison, U. S. A. |
| Annales des Ponts et Chaussées. <i>m</i> . Paris. | Bull. Int. Railway Congress. <i>m</i> . Brussels. |
| Ann. d Soc. Ing. d Arch Ital. <i>s-m</i> . Rome. | Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. <i>m</i> |
| Architect. <i>w</i> . London. | Liège. |
| Architectural Record. <i>m</i> . New York. | Bull. Tech. de la Suisse Romande. <i>s-m</i> . Lausanne. |
| Architectural Review. <i>s-q</i> . Boston. | Bull. Univ. of Illinois, Urbana, Ill. |
| Architect's and Builder's Magazine. <i>m</i> . New York. | Bureau of Mines, Washington. |
| Australian Mining Standard. <i>w</i> . Melbourne. | Canadian Electrical News. <i>m</i> . Toronto. |
| Autocar. <i>w</i> . Coventry, England. | Canadian Engineer. <i>w</i> . Toronto and Montreal. |
| Automobile. <i>w</i> . New York. | Canadian Mining Journal. <i>b-w</i> . Toronto. |
| Automotor Journal. <i>w</i> . London. | Cassier's Magazine. <i>m</i> . New York and London. |
| Beton und Eisen. <i>qr</i> . Vienna. | Castings. <i>m</i> . Cleveland, O. |
| Boiler Maker. <i>m</i> . New York. | Cement. <i>m</i> . New York. |
| Brass World. <i>m</i> . Bridgeport, Conn. | Cement Age. <i>m</i> . New York. |
| Brickbuilder. <i>m</i> . Boston. | Chemical Engineer. <i>m</i> . Chicago. |
| Builder. <i>w</i> . London. | Chem. Met. Soc. of S. Africa. <i>m</i> . Johannesburg. |
| Bull. Bur. of Standards. <i>qr</i> . Washington. | Colliery Guardian. <i>w</i> . London. |
| Bulletin de la Société d'Encouragement. <i>m</i> . Paris. | Commercial Vehicle. <i>m</i> . New York. |

- Compressed Air. *m.* New York.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering and Contracting. *w.* Chicago.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Turin.
 Industria. *w.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal N. E. Water Works Assn. *qr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Journal Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of England. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 La Nature. *w.* Paris.
 Le Yacht. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Métallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining and Engineering World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Moniteur Industrielle. *w.* Paris.
 Monitore Tecnico. *tr-m.* Milan.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *qr.* Philadelphia.
 Pro. Engineers Society of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Quarry. *m.* London.
 Queensland Government Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Locomotive Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Génie des Chemins de Fer. *m.* Paris.
 Revue Génie des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific American Supplement. *w.* New York.
 Sibley Journal of Mech. Eng. *m.* Ithaca, N. Y.
 Société Belge des Electriciens. *m.* Brussels.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD of NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Aerial Ropeways

Aerial or Wire Rope-Ways. By A. J. Wallis-Taylor. Size 9 by 5½ in.; pp., 246. Ills. Price \$3.00. New York: D. Van Nostrand Company.

A republication of an older book by the same author, revised and modernized, with chapters on electric, endless and fixed carrying-rope systems; hoisting and conveying ropes, and miscellaneous information on ropes.

Aeroplanes

The Mechanics of the Aeroplane. By Capt. Duchêne, translated by J. H. Ledebor and T. O'B. Hubbard. Size, 8½ by 5½ in.; pp., 231. Ills. Price \$2.25. London: Longmans, Green & Co.

Dealing, first, with the support of the aeroplane in still air; second, equilibrium and stability; third, wind effects, and, finally, an appendix on screw propellers.

Building Construction

The Mechanics of Building Construction. By Henry Adams. Size, 8½ by 5½ in.; pp., 240. Ills. Price, \$2.00. London and New York: Longmans, Green & Co.

A series of lectures delivered before science teachers at South Kensington, upon the principles of Structural Engineering, covering the whole ground needed by students who intend to specialize as architects or structural engineers.

Canada

Report of the Commission of Conservation on Lands, Fisheries and Game, and Minerals, for 1911. Size, 9½ by 7 in.; pp., 519. Ills. Ottawa: The Mortimer Co., Ltd.

The work covers the agricultural development of Canada; the fisheries and game laws and industry, and a report on the mining laws and mineral production, for the year.

Chemistry

Kurze Analysen - Vorschriften. By Ernst Pancke. Size, 9½ by 6½ in.; pp., 42. Price, Mark 2.40. Halle a. S.: Wilhelm Knapp.

An outline of test methods for the particular use of foundry laboratories.

Chicago Drainage

Papers Relating to the Application of the Sanitary District of Chicago for Permission to Divert 10,000 cu. ft. of Water per Second from Lake Michigan. Size,

9 by 6 in.; pp., 270. Ottawa: C. H. Parmelee.

Complete report of all matters relating to such diversion; the argument before the United States Secretary of War, and the reply of the Chicago Sanitary District.

Coals of Canada

An Investigation of the Coals of Canada with Reference to their Economic Qualities. Vol. II. By J. B. Porter, R. J. Durley, and others. Size, 6½ by 10 in.; pp., 189. Ills. Ottawa: Government Printing Bureau.

The second of six volumes. As noted in previous review of Volume I., this volume is devoted to boiler tests, gas-producer tests, and laboratory investigations.

Colombia

The Mining Laws of the Republic of Colombia. By Phanor J. Eder. Size, 9 by 6 in.; pp., 150. New York: Phanor J. Eder.

A translation of the present mining laws of the country, by a lawyer, for the benefit of English and American capitalists who have interests in the country.

Concrete

Concrete Costs. By Frederick W. Taylor and Sanford E. Thompson. Size, 7½ by 5 in.; pp., 709. Ills. Price, \$5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

For the use of architects, engineers and contractors in estimating the cost of concrete works and structures. Also intended to indicate from the application of motion and time study how the work may be laid out and performed to give maximum production with minimum cost.

Constants and Numerical Data

Annual Tables of Constants and Numerical Data; Chemical, Physical and Technological. Edited by Ch. Marie. Size 10½ by 9 in.; pp., 727. Price \$6.00 bound. Chicago: University of Chicago Press. London: J. & A. Churchill. Paris: Gautier - Villars. Leipzig: Akademische Verlagsgesellschaft.

Volume I. is a compilation under the authority of the International Association of Academies, of such tables and data obtained from technical papers and periodicals during the year 1910, in four languages—French, German, English and Italian.

Education

Report of the Commissioner of Education. Vol I. By P. P. Claxton. Size, 9 by 5½ in.; pp., 675. Washington: Government Printing Office.

Volume I., of the report for the year ending June 30, 1911, contains a brief survey of educational progress during the past decade, together with chapters on education in all its several fields throughout the United States and other countries.

Geology

Report on the Geology and Mineral Resources of the Chibougamau Region, Quebec. By J. C. Gwillim, E. R. Faribault and A. E. Barlow. Size, 9¾ by 5½ in.; pp., 224. Ills. Quebec: Government Printing Bureau.

A general historic and economic review of the resources of the region.

Bulletin of the Geological Institution of the University of Upsala. Edited by H. S. Sjögren. Size 10 by 6½ in., pp., 305. Ills. Uppsala: Almqvist & Wiksells.

A collection of six papers by various authors on the geological research work under the authority of the University.

Heating

Principles of Heating. By William G. Snow. Size 9 by 6 in.; pp., 224. Ills. Price \$2.00. New York: David Williams Company.

A revision of an earlier work by the author. Among the subjects considered are: Central Station Heating Systems; Substitutes for Coal in Furnishing Heat; Heat Transmission Losses; Non-Conducting Coverings, etc.

Industrial Chemistry

An Introduction to the Study of Fuel. By F. J. Brislee. Size, 9 by 5½ in.; pp., 269. Ills. Price, \$3.00. New York: D. Van Nostrand Company.

The first of a series of volumes on Industrial Chemistry by several authorities. This volume on "Fuel," by Dr. Brislee, is intended for the use of engineering students and others concerned in the purchase, valuation, and utilization of fuel.

Internal Combustion Engines

Internal Combustion Engine Manual. By F. W. Sterling. Size, 9 by 6 in.; pp., 146. Ills. Price, \$1.75. Baltimore: The Lord Baltimore Press.

A text book taking up the subjects of fuel, fuel systems, ignition, cooling, lubrication, and a brief discussion on producer plants.

Elementary Internal Combustion Engines. By J. W. Kershaw. Size, 7½ by 5½ in.; pp., 174. Ills. Price, 90c. London and New York: Longmans, Green & Co.

This book is intended to give an elementary account of the construction and working of internal combustion engines

and power gas producers, and to serve as an introduction to more advanced books on the subject.

Management

Primer of Scientific Management. By Frank B. Gilbreth. Size, 7½ by 5 in.; pp., 108. Price, \$1.00. New York: D. Van Nostrand Company.

A book prepared by the author in answer to numerous requests for further information on the subject of the principles of scientific management on the lines as laid down by F. W. Taylor.

Mechanics

Introduction to Analytical Mechanics. By Alexander Ziwet and Peter Field. Size, 7½ by 5 ins.; pp., 378. Price, \$1.60. New York: The Macmillan Company.

Intended as a brief introduction to mechanics for junior and senior students in colleges and universities, omitting the applications to engineering, and presupposing no knowledge of differential equations.

Metallurgy

Nouveauté en Metallurgie. By Mathieu Douteur. Size, 9½ by 6 in.; pp., 70. Ills. Price, 3 Frs. Paris: Mois Scientifique et Industriel.

Especially descriptive of a new process devised by the author for use in solidifying steel.

Mine Structures

The Design of Mine Structures. By Milo S. Ketchum. Size, 9 by 6 in.; pp., 459. Ills. Price, \$4.00. New York: McGraw-Hill Book Company.

Discusses the design of mine headworks in particular, but also buildings, bins, coal washers and breakers, etc. Supplementary to previous works by the author.

Nomograms

Les Nomogrammes de l'Ingénieur. By R. Seco de la Garza. Size, 8½ by 6½ in.; pp., 196. Ills. Price, 12 Frs. Paris: Gauthier-Villars.

A comprehensive description of the formation of the nomograms, and an explanation of their use in ordinary numerical calculations.

Open-Hearth

The Basic Open-Hearth Steel Process. By Carl Dichman. Size, 8½ by 5½ in.; pp., 334. Ills. Price, \$3.50. New York: D. Van Nostrand Company.

A translation, by Alleyne Reynolds, covering both the physics and chemistry of the process, including the operation of gas producers, the raw materials for producer working, and the complete process in the open-hearth furnace.

Pumping Machinery

Centrifugal Pumping Machinery. By Carl George de Laval. Size, 9 by 6 ins.;

pp., 184. Ills. Price, \$3.00. New York and London: McGraw-Hill Book Company.

Primarily for designers of centrifugal and turbine pumps. The data are based upon experience in design, construction and installation. The material is confined to that which has been successful in actual practice.

Reinforced Concrete

Reinforced Concrete Buildings. By Ernest L. Ransome and Alexis Saurbrey. Size, 9 by 6 ins.; pp., 235. Ills. Price, \$2.50. New York and London: McGraw-Hill Book Company.

In three parts. Part I. gives a history of reinforced concrete, with special reference to United States patents; Part II. covers the theory of the design of beams and slabs; Part III. is devoted to practical construction.

Reinforced Concrete Design. By Oscar Faber and P. G. Bowie. Size $8\frac{1}{2}$ by $5\frac{1}{2}$ in.; pp., 332. Ills. Price, \$3.50. New York: Longmans, Green & Co. London: Edward Arnold.

Giving first the general underlying principles of concrete reinforcement. Part I., the calculation of stresses. Part II., design of columns. Part III., design of beams and slabs. Part IV., applications and general notes.

Scientific Management

Scientific Management. Size, 9 by 6 in.; pp., 387. Ills. Price, \$2.50. Boston: The Weekly Bulletin Publishing Co.

Address and discussion by some of the leading exponents at the Dartmouth College (Tuck School) Conference on Scientific Management, held October 12, 13 and 14, 1911.

Society Proceedings

Proceedings of the Fourth Meeting of the Illinois Water Supply Association. Size 9 by 6 in.; pp., 260. Ills. Published by the Society. Urbana, Illinois.

Papers and discussions presented at the meeting at the University of Illinois, March, 1912.

Proceedings of the Thirty-first Annual Convention of the American Water Works Association. Size, 9 by 6 in.; pp. 483. Ills. Published by the Secretary of the Association, Troy, N. Y.

A publication of the papers and discussions presented at the Rochester Convention, June, 1911.

The Journal of the Canadian Mining Institute. Size, $8\frac{3}{4}$ by $5\frac{3}{4}$ ins.; pp., 730. Ills. Published by the Secretary of the Institute, Montreal.

A publication of the papers and discussions presented before the annual meeting of the Institute in Quebec, March, 1911.

Specifications

The Principles of Specification and Agreement Writing. By C. R. Young. Size, 9 by 6 in.; pp., 47. Price, 25c. Toronto: The Canadian Engineer.

An outline of the fundamental principles in the more common forms of construction contracts, for use in engineering offices.

Stoichiometry

Chemical Arithmetic and Calculation of Furnace Charges. By Regis Chauvenet. Size $9\frac{1}{4}$ by 6 in.; pp., 302. Price \$4.00. Philadelphia and London: J. B. Lippincott Company.

Intended as a text-book. Part I. covers the elementary subdivisions of stoichiometry, including problems. Part II., in addition to slag calculations, presents a method for figuring furnace charges.

Structural Design

The Elements of Structural Design. By Horace R. Thayer. Size, 9 by 6 in.; pp., 221. Ills. Price, \$2.00. New York: D. Van Nostrand Company.

Intended for students and draughtsmen who understand mechanics, stresses, and the mathematics thereby involved. Considers wooden structures and the elements of steel design.

Subways

The Subways and Tunnels of New York. By Gilbert H. Gilbert, Lucius I. Wightman and W. L. Saunders. Size, 9 by 6 in.; pp., 372. Ills. Price, \$4.00. New York: John Wiley & Sons.

Details on the methods and costs in the construction of the Triborough subway system. The eight subaqueous tunnels under the East River; the six under the Hudson; two under the Bronx; the McAdoo system, and the Pennsylvania R. R. system.

Ultra-Violet Rays

Les Rayons Ultra-Violets et Leurs Applications. By the Institut Scientifique et Industriel. Size, $9\frac{1}{2}$ by 6 in.; pp., 70. Ills. Price, 2 Frs. 75. Paris: Mois Scientifique et Industriel.

A compilation giving and defining the properties of the rays, and describing applications of the rays in mercury tubes, water sterilization, medical and other purposes.

Valuation

Engineering Valuation of Public Utilities and Factories. By Horatio A. Foster. Size, 9 by 6 ins.; pp., 345. Price, \$3.00. New York: D. Van Nostrand Company.

An attempt to describe the elements entering into a thorough valuation. Including court opinions embodying instructions for valuation; various forms in use; methods for calculating depreciation; capitalization and sinking funds.



VOL. XLIII

SEPTEMBER, 1912

No. 6

IRON-ORE RESERVES

By Edwin C. Eckel

II. THEIR EXTENT AND DURATION

Mr. Eckel's article in its entirety covers three basic questions concerning the American iron and steel trade and the engineering and manufacturing industries dependent upon it. These are the extent and duration of the resources, their valuation, and the possibility or effect of monopolistic control. In presentation the order of sequence is that determined by immediate public interest. The examination of monopoly possibilities and limitations appeared last month. The concluding article, on valuation, will be published in October.—THE EDITORS.

IN the first article of this series, presented in the August issue of THE ENGINEERING MAGAZINE, attention was directed to the general principles which render necessary as well as justifiable the ownership of reasonable ore reserves by iron and steel manufacturing companies; but which also operate to prevent unreasonable accumulation of such reserves. That discussion was entirely general in its scope and application, and it was not necessary to restrict it to the ore reserves of any particular company or even of any particular country. A steel plant of a given size will have substantially the same reserve requirements, regardless of whether it is located in Germany or America, and equally regardless of whether it is owned by individuals or by a corporation.

The present article, however, will for convenience be restricted in scope to a consideration of the actual ore situation in the United States and its industrially tributary territory. After summarizing briefly the available data as to the total ore reserves of this territory, it will be possible to form some opinion as to how the future development of the American iron industry is likely to be affected as the yearly drafts on these ore supplies become larger and reach nearer to the exhaustion point, so far as the higher-grade ores are concerned. This last qualification is important, for there is really no basis for alarmist statements as to the impending exhaustion of iron ores in general. On the other hand, we may as well face the fact now as later that our average ore grade is likely to de-

crease steadily, in spite of importations, and that this decrease in ore grade will necessarily entail certain important economic effects. It will be a gain for all concerned if it is generally understood that these effects will be entirely natural, and that they cannot be avoided or prevented by any conceivable legal or political action. This matter will be taken up toward the close of the present article.

THE CREDIBILITY OF RESERVE ESTIMATES

Before going on to a statement of the various estimates which have been made as to American and tributary iron-ore reserve tonnages, it may not be amiss to consider briefly the manner in which such estimates are made, and the extent to which they can be relied on. Though the matter is purely technical in its nature, it should be possible to explain its principles and results in non-technical language.

There are three different sets of factors involved in making an estimate of the tonnage of ore contained in any given property or region. In each case, whether the area and tonnage considered be large or small, we start from a basis of engineering facts, interpret and utilize these facts by means of geologic deductions, and finally correct our tonnage estimates in the light of industrial conditions. An example may make this clearer, and since the principles involved do not vary with the size of the area, we may assume that a single small property is under consideration. In attempting to determine its ore tonnage, there are to be considered first of all the facts that workable ore is shown in some or all of a number of natural exposures, artificial openings, test-pits, or drill-holes. These facts as to occurrence and thickness must be interpreted geologically, for

the isolated records mean little unless some idea can be secured as to the form and geological relations of the ore body. Finally, consideration must be given to the effects of ore grade, working conditions, transportation, etc. It will be seen that the industrial factors last mentioned are really the ones on which differences of opinion can most readily exist. Two men of approximately equal experience and training can hardly differ as to the records of the drill-holes; they may differ somewhat as to the geologic interpretation of those records; but they may differ very widely in their ideas as to how much of the ore can be considered available under existing industrial conditions. When the problem is rendered more complicated by attempting to determine what ore will be available under *future* industrial conditions, the differences in opinion are apt to be still wider.

This is an important fact, and must be borne in mind when comparisons are made between tonnage estimates by different authorities. When these estimates differ widely, examination will usually show that there is substantial agreement as to the facts of the case, and that the differences in the final statement are due chiefly to the point at which the line between available and non-available ore has been drawn. In considering the various estimates which have been made as to the total iron-ore reserves of the United States, which will next be taken up, this phase of the matter must be kept in mind steadily.

At the outset the reader will do well to understand that estimates of our total iron-ore reserves, and anxiety over their probable duration, are matters of very recent date. England has suffered periodically, for almost a century, from attacks of

panic over the impending exhaustion of her coal supply; and the duration of our own supply of Pennsylvania anthracite has been a subject of serious discussion for some time. But the fear of exhausted iron ores does not date back as much as ten years, and its commencement in this country was due to the publication of a foreign report whose absurdity should have been enough of itself to render it harmless.

consumption than we are to reduce it. The world has only 10,000,000,000 tons of iron ore available. Of these Germany has twice as many tons as the United States. Russia and France each have 400,000,000 tons more than this country. * * * Assuming therefore as true the claim of geological science that the extent of workable iron-ore beds is known to within a margin of possible error not exceeding 5 per cent, the Swedish report, which is based upon the most authoritative information has naturally attracted world-wide attention. * * * The present output of ore and the amount of ore actually consumed by each is as follows, in tons:

Country	Workable deposits	Annual output	Annual consumption
United States.....	1,100,000,000	35,000,000	35,000,000
Great Britain.....	1,000,000,000	14,000,000	20,000,000
Germany	2,200,000,000	21,000,000	24,000,000
Spain	500,000,000	8,000,000	1,000,000
Russia and Finland.....	1,500,000,000	4,000,000	6,000,000
France	1,500,000,000	6,000,000	8,000,000
Sweden	1,000,000,000	4,000,000	1,000,000
Austria-Hungary	1,200,000,000	3,000,000	4,000,000
Other countries.....	1,200,000,000	5,000,000	1,000,000
Total.....	10,000,000,000	100,000,000	100,000,000

THE TÖRNEBOHM ESTIMATE OF 1905

In 1905, in response to a request from the Swedish Parliament, an eminent Swedish geologist, Professor A. E. Törnebohm, prepared a report on the iron-ore resources of the world. In its original form, the report attracted little notice in the United States, even among those directly interested in the iron industry. Early in 1906, however, a summarized translation of the report was forwarded home by the American consul at Paris, and the wide circulation which is given to consular reports in the United States resulted in drawing considerable attention to the matter in both the daily and the technical press.

The character of the Törnebohm report, in the form in which it reached the American public, is fairly indicated by the following extracts:

It will surprise a great many to learn that we are likely to run short in iron inside of a single century, if we keep up the present rate of consumption. As a matter of fact we are more likely to increase the

While it is probable that the foregoing statement does not take into adequate account the undeveloped ore deposits of Utah and Alabama, its teachings are nevertheless obvious and impressive. Of the world's workable iron-ore deposits, as at present known, the United States possesses only about one-ninth, and at the present rate of consumption the entire supply will be exhausted within the present century.

Of the eleven hundred million tons credited by Törnebohm to the United States, an even ten hundred million were to come from the Lake regions; sixty million from Alabama, with some evident doubt by the Swedish geologist as to what these Alabama ores really were; and the remaining forty million were widely distributed.

If properly understood, as a report intended to assure the Swedish people that they controlled a very respectable percentage of the world's supply of high-grade ores, the Törnebohm report was really effective. From any other point of view it should not have been taken seriously. Its publication by our Consular Bureau, however, gave it a semi-offi-

cial aspect; and in its summarized and annotated form its newspaper career was amazing.

At different times in 1905 and 1906, the Törnebohm report was discussed in print by various authorities. Among others, Hadfield, Shaler, Birkinbine and Leith mentioned it or treated phases of the same subject, while most of the technical journals commented on it editorially. Practically all these commentators deprecated the low estimates of the Swedish geologist, but no new data for revised estimates were offered as substitutes. At that date the writer was in charge of the iron-ore investigations of the United States Geological Survey, and was more directly interested in the detailed work on Southern iron ores which had commenced in 1905. The Törnebohm estimate for the South was so curiously far from the facts of the case that opportunity was taken to review the entire matter in the official report on Iron-Ore Production of the United States for 1906. Preliminary estimates were given for the more important southern States.

THE HAYES ESTIMATE OF 1908

No one connected with the American iron industry was really worrying over a possible shortage in our ore-supply, and the matter might perhaps have been dropped at this stage if it had not become entangled with the conservation problem which about that time was being considered by a strenuous executive, a puzzled Congress, and a series of excited organizations ranging from sewing circles to lumber dealers. Everyone who remembers that remarkable episode will recall with pained surprise the unanimity with which we all considered gloomily, in turn, the impending scarcity of the food supply and the possible utilizations of

sawdust; the decreasing number of Western farmers and the increase in Southern boll-weevils; the substitution of steel for timber, because wood was a luxury—and then later the substitution of concrete for steel because steel would be reserved for coinage. Looking back at it, the pity of it is that all of this national worry was so futile; for how many of the good resolutions made then have been kept? We have, it is true, a more efficient forest service, and a tangible forestry plan. Also, it might be added, the pension list has been kept from decreasing, the Alaska coal is yet intact for future generations, and congressional mileage is still jealously conserved. But with these striking exceptions, the net gain has been very small in proportion to the enthusiasm developed.

One of the good features of the conservation movement was the establishment of a commission to inventory the more important raw materials of the United States. The examination of the iron-ore question was assigned to C. W. Hayes, then Chief Geologist of the United States Geological Survey; and the result was the publication of a most important and detailed estimate of our total iron reserves. Dr. Hayes had a wide acquaintance with American iron ores; and sufficient time and money were available to do the work properly. His report must stand as the basis for all future discussions of this subject.

Hayes' final figures, by districts, are shown by the table at the top of the following page.

In order to obtain any adequate idea of the valuable local data utilized in the Hayes estimate which is summarized above, reference must be made to the original report. At present it need only be said that little criticism can be directed against

Districts	Total Reserves, in Tons	
	Available	Not Available
Northeastern	298,000,000	1,095,000,000
Southeastern	538,440,000	1,276,500,000
Lake Superior	3,510,000,000	72,030,000,000
Mississippi Valley	315,000,000	570,000,000
Rocky Mountain	57,760,000	120,665,000
Pacific Slope	68,950,000	23,905,000
Total United States	4,788,150,000	75,116,070,000

THE HAYES ESTIMATE

the details of the estimate, or against the comprehensiveness of the plan on which it was based. The point which does require attention is the distinction which Hayes made between "available" and "non-available" ore reserve. In the writer's opinion, the defect of the Hayes estimate arises from the fact that this distinction was not carried out on the same basis in the different districts. This matter will be taken up in more detail later, but at present it need only be said that Hayes' practice in this regard tends to increase his estimates of Lake ores and to decrease his estimates of Southern ores. His "non-available" ores in the South include large tonnages which would be merchantable today; his "non-available" ores in the Lake region include rocks of a type which will probably never be used in the iron furnace.

THE BUTLER-BIRKINBINE ESTIMATE
OF 1909

During 1909, but after the publication of the Hayes estimate which has just been discussed, a very interesting estimate appeared in a brief filed before the Senate Finance Committee by Mr. Joseph G. Butler, jr. The brief covered the entire question of the iron-ore situation in the United States, and brings up a number of considerations overlooked in previous estimates. In this report Mr. Butler was assisted by Mr. John Birkinbine.

This estimate gives, as the total tonnage of iron ores of present commercial standard available in the im-

mediate future, the following figures for the various districts:

Area	Tons
Lake Superior region	1,618,000,000
Southern States	1,814,940,000
New York	750,000,000
New Jersey	135,000,000
Pennsylvania	45,000,000
Rocky Mountain region	100,000,000

Total available, United States 4,462,940,000

On comparison of the Butler-Birkinbine and the Hayes estimates, it will be seen that they agree closely in their figures for total available ore, the two totals being 4,462,940,000 and 4,788,150,000 tons respectively. In the distribution of this total among the various districts, however, they differ widely. The Hayes estimate for the Lake region is cut in half; but his figures for the South and for the northeastern States are more than doubled. These changes seem to me to be entirely in line with the facts of the case, so that in this respect the Butler-Birkinbine estimate may be considered to be a distinct advance upon all previous figures.

REVISED ESTIMATES, 1912

In the estimate now to be presented, I have taken advantage of all the earlier work heretofore quoted, and have revised and re-arranged the results so as to accord with my personal experience and with recent work in various areas by others. The result is presented with some confidence, as representing at least a fair statement of the case, in the light of present knowledge.

In taking up the Lake Superior

district we are struck at first by the wide variation between the estimates of various reputable authorities; but on considering their statements more carefully it will be found that the differences are more apparent than real, and that they are really differences of definition rather than of fact. The four important recent estimates give totals for the Lake region as follows:

Authority	Tons
Hayes	3,510,000,000
Van Hise and Leith	1,905,000,000
Butler-Birkinbine	1,618,000,000
Minnesota - Michigan Tax Commission	1,584,000,000

On examining the data on which estimates must be based, it appears that the Minnesota Tax Commission assesses the Mesaba and Vermillion ranges in that State as containing practically fourteen hundred million tons; and that the very able engineer who acted for the Michigan Tax Commissioners estimated the assessable tonnage on the Michigan ranges at practically two hundred million tons. There is, to start with, a universally accepted total amount of sixteen hundred million tons.

To this must be added the tonnage in certain ranges not considered in the above assessments; the possibilities of new tonnage in undeveloped territory; and the possibility that the assessed tonnages were themselves actually too low. With regard to the first point, tonnages must be added for the Cuyuna range in Minnesota, the Baraboo and Clinton ores of Wisconsin; and the Wisconsin portions of the Menominee and Gogebic ranges. It is probable that no one would think of crediting this group with a total of less than one hundred million tons, and most estimates would probably run considerably higher. The definite Lake aggregate so far is therefore seventeen hundred million tons.

With regard to the two remaining features which will add to this total there is obviously large room for individual opinion. Finlay estimates that in addition to the assessed tonnages on the Michigan ranges, there are in all probability over one hundred and fifty million tons which these ranges will, in the aggregate, produce. In Minnesota we have to deal with the certainty that a system which taxes ore in the ground is not calculated to encourage exploration or development far in advance of actual requirements. And there is, of course, the further possibility of new discoveries in territory now unprospected.

Taking all of these facts into consideration, it is difficult to place the tonnage of strictly available ore of present-day commercial grade in the Lake region at less than two-thousand million tons; and it is probable that twenty-five hundred million tons would really be nearer to the truth. But for present purposes the lower figure can be accepted with substantial safety.

The available data regarding the ore reserves of the northeastern States are still very poor, so that there is room for wide difference of opinion here as to total tonnages. Newland has given detailed estimates of the Clinton ores of New York; but concerning the important magnetite deposits of the Adirondacks, the highlands of New York and New Jersey, and southeastern Pennsylvania, we have really very little reliable information. Descriptions of the geology of the various districts exist in profusion, but in most of these no attempt whatever has been made to give any consideration to the quantitative side of the matter. Under these circumstances Hayes' estimates for the northeastern States may be accepted tentatively as the best available at the moment, though

it is hoped that better data will be in hand in the near future.

The Hayes figures for the available ores of this region are approximately three hundred million tons. This is certainly close to the *minimum* tonnage available; and at the present moment, until closer work has been done in some of the districts, we might assume that the *maximum* tonnage which we might expect would be perhaps six hundred million tons.

For the Rocky Mountain and Pacific States Hayes figures one hundred and twenty-six million tons of available ore. As our information stands now, this is almost certainly a heavy under-estimate, for Utah alone would show a far heavier tonnage. With regard to the other western States data are scanty, and the range of estimate in this district must be wider than in other parts of the United States. For our present purposes it will not seriously affect the accuracy of the final results if we put the western States down for a minimum of three hundred million tons and a possible maximum of seven hundred million.

In making up his figures for the southeastern and Mississippi Valley districts, here considered together as the southern district, Hayes certainly drew the line between available and non-available ores in a different way from that employed in his Lake estimates. The result is that the

be necessary to go over the data for each mining region in detail. Space is not available for these computations in the present article, but the final results may be presented briefly.

In the Hayes estimates, three of the southern districts suffered more severely than the others, being credited with far less than their minimum possible tonnages. These are (1) the Birmingham red-ore region, (2) the brown-ore area of northeast Texas and (3) the extensive brown-ore region reaching from northwest Alabama through middle and west Tennessee into Kentucky. In each case there were obvious reasons for the under-estimates. At the time Hayes prepared his report Texan ores seemed likely to be out of the market for many years to come; but recent freight arrangements will put them into eastern ports on a parity with Cuban ores of lower grade. In the Birmingham district there has been considerable recent development which enables us to count on far heavier tonnages.

Taking all of these facts into consideration, the figures given in the table below are probably justified in the light of existing knowledge as to conditions in the various districts. They are subject to change as more details can be secured. It is worthy of note, however, that such changes will almost inevitably be in the direction of raising the total minimum tonnage here counted on as available.

AMERICAN RESERVE TONNAGES

District	Range of Estimate	
Lake Superior.....	2,000,000,000	2,500,000,000
Northeastern	300,000,000	600,000,000
Western	300,000,000	700,000,000
Birmingham	1,500,000,000	2,000,000,000
Texas	600,000,000	1,000,000,000
Other Southern.....	500,000,000	750,000,000
Total United States.....	5,200,000,000	7,550,000,000

two sets of figures are not even remotely comparable. In order to put them on the same footing, it would

The above estimates include only ores of present-day commercial grade—such ores as are now used during

years of business prosperity. They do not include the enormous reserves of very low grade red ores in the south, or the low-grade siliceous ores of the Lake region.

The minimum figures, in each case, represent the lowest estimates which anyone, writing today, could possibly credit to the various districts. The higher figures represent the tonnages which may fairly be hoped for; and are in my opinion, the closer to the truth.

TRIBUTARY RESERVES

It will be seen from the preceding discussion that, to adopt an average figure, we can count on six and a half thousand million tons of American iron ore, before being compelled to accept a very startling decrease in grade. But the geographic distribution of this tonnage is such that, if there were no outside supplies, we would have to face very dear pig-iron within comparatively few years. Fortunately the free importation of foreign ores will help out in this direction, though it will be seen later that the effect of lowering ore grades will be noticeable even with this aid.

In speaking of tributary ore reserves it is hardly fair to include the Spanish, Scandinavian and other Old World ores, for though some of them are imported heavily even now, they will ultimately be bought in competition with European furnaces which will need them worse than ours. The reserve tonnage which is, however, properly tributary to American furnaces, includes the ore deposits of Canada, Newfoundland, the West Indies, Venezuela, Brazil, and possibly Mexico. Other large ore reserves will almost certainly be uncovered in the Caribbean region, and possibly elsewhere to the south of us, but the reserves already known are sufficiently large to give a long lease of life to the American steel industry.

Some idea of the extent of the tonnage now available may be gained by considering that Spencer estimates that the Cuban brown-ore fields will yield three thousand million tons; and this is probably a very conservative statement of the matter. Other islands of the West Indies are known to carry similar ores, while bordering portions of the mainland show deposits of related type. The Brazilian iron-ore ranges are of the same order of magnitude as our own Lake ranges, while their ore grade is notably higher than the average now obtainable from the Lake. The ores of Canada and Newfoundland do not give promise of being so extensive as those already mentioned, but their reserve tonnage is still heavy.

Taking all of the known tributary ore fields into account, and making a very small additional allowance for extensions, it is probably well within limits to assume that there are six or seven thousand million tons of merchantable ore, in countries adjacent to the United States, which is more likely to be used in American furnaces than near the mines.

The United States has been an importer of iron ore for many years, but until 1879 the importations never amounted to over forty or fifty thousand tons annually. Since that date they have increased, though not steadily; but with the comparatively recent development of the ore fields on the north coast of Cuba the increase is becoming more marked. In 1910, for example, the importations amounted to nearly two million six hundred thousand tons, of which somewhat over half came from Cuba.

As the grade of our Lake shipments gradually decreases, the imported ores will naturally become of increasing importance to the American iron industry. Their importa-

tion and use will tend to keep the cost of manufacturing pig-iron from rising as rapidly as it otherwise would. Imported ores will not be able to stop the trend toward higher manufacturing costs, but they will retard the process somewhat. There are no conceivable circumstances under which American furnaces will be able to make pig-iron as cheaply as during the years of 1893-1897.

THE DRAFT ON OUR RESERVES

No detailed and accurate figures are available as to American iron-ore production prior to 1889, so that it is not possible to state directly the rate at which our iron ores have been drawn on in the past. But this defect can be remedied by using the data as to pig-iron production, which have been recorded steadily for sixty years, while earlier scattered records enable us to carry the figures back to 1800.

The following table has been prepared by me for use in this connection. The figures prior to 1854 are estimates made from scattered data. For the later years, the data are those collected annually by the American Iron and Steel Association, and may be accepted as final.

PRODUCTION OF PIG IRON, BY DECADES,
1800-1910

Decades	Long tons
1801-1810.....	500,000
1811-1820.....	350,000
1821-1830.....	1,000,000
1831-1840.....	2,300,000
1841-1850.....	4,945,000
1851-1860.....	6,818,737
1861-1870.....	11,366,963
1871-1880.....	24,055,278
1881-1890.....	56,902,041
1891-1900.....	98,124,754
1901-1910.....	211,321,934

On inspection of the preceding table it will be seen that the American production of pig iron has, on the average, somewhat more than doubled in each decade. Of course there will be a point at which this rate of

increase will be lowered, but at present we must accept the possibility that it will continue for at least a few decades more. What this means in the way of iron-ore requirements can be estimated closely enough for our present purpose by assuming that at present a ton of pig iron represents slightly over two tons of iron ore; and that the ratio of ore to pig is rising each year. Unless iron production slackens, it will therefore be necessary in the decade 1911-1920 to use about four hundred and fifty million tons of ore; while the next decade will require close to one thousand million tons.

If this draft on our ore resources, great though it seems, were distributed evenly the results would not be industrially serious for several decades more. But since the bulk of the ore is at present drawn from one district, there is evidently some reason to give consideration to the matter.

THE FUTURE COURSE OF ORE GRADES

So far as our domestic supplies of iron ore are concerned, the factors which bear upon this problem are sufficiently well defined as to admit of little error in outlining the probable future course of ore grades. With regard to imported ores the case is different, for here we are dealing apparently with an early stage in a movement whose final limits can not well be set. In discussing the course which average ore grades will probably take in the future, it is therefore advisable to consider first the conditions as to domestic supply, and then make some attempt to outline the probabilities as regards imported ores.

The Lake Superior ores, which now are the mainstay of the American iron industry, are showing a fairly steady decrease in grade from

year to year. The falling off in the average grade of the Lake ores, over the past ten or fifteen years, has been about one-half of one per cent a year. Part of this decrease is necessary while part is due to intentional use of lower grades during years of large shipment. Conservation of the total supply by such intermixture of low-grade ores is commercially possible only for such companies as operate on a large scale and with the expectation of remaining in the business for many years to come. The small independent producer, in this as in other industries, is forced to operate un-economically, and to ship his best ore each year, regardless of prices or business conditions.

If the Lake Superior district were the sole source of supply, it could be assumed with fair safety that the average grade would decrease slowly but steadily for some years to come; that the heavy reserves of ore in the neighborhood of 45 per cent iron would hold the average temporarily around that point for a period of years; and that between 40 and 35 per cent the demand could be met almost indefinitely without causing further decrease in grade. When the Lake Superior average grade reaches 45 per cent, therefore, its further downward progress will be very slow; and at 40 per cent or somewhat less the decrease will be checked for a great number of years.

Considering our Southern supplies in similar detached fashion, it may be assumed that the average red ore today is little if any above 36 per cent iron. Of course, being limy ores, these 36 per cent red ores would rank commercially far above siliceous Lake ores of equal iron grade. Without attempting a precise comparison, it may perhaps be assumed for present purposes that they

are commercially equivalent to a Lake ore carrying 45 to 47 per cent iron. The fact of interest, however, is that there are very heavy reserve tonnages of this 36 per cent grade available, as compared with either the present Southern rate of ore consumption, or with any future rate which seems probable. The decrease in average Southern grade will therefore be very slow, and if in time the demand justifies the use of 30 per cent ore, the reserves of this grade available are sufficient practically to stop any further decrease.

A third source of supply that seems to be just on the verge of becoming a more important factor in the situation is the magnetite reserve in the eastern and Southern States. Apparently a slight further decrease in average grade of the Lake ore will open the way for marketing large tonnages of magnetic ores, in addition to the amounts which are now annually used in eastern furnaces.

In the preceding sections the possibilities of the Lake hematites, the Southern red ores and the Eastern magnetites have been separately considered. It is now possible, still disregarding the question of imported ores, to group these results and obtain some idea as to the domestic ore situation. The matter might be summarized by saying that grade will probably decrease slowly until 45 per cent is reached; that its further decrease to 40 per cent will be very slow, owing to the large Lake tonnages available at this level, to the relative slow fall in Southern grade, and to the increasing use of magnetic ores. Below 40 per cent the decrease would be so slow as to be hardly noticeable, until the domestic reserves are entirely exhausted. If the Lake district ever gets down to a 37 per cent average, the South

would be running on 30 per cent ore; and the average for the country might be 35 per cent or thereabouts.

Heretofore our attention has been confined, for the sake of clearness, to the domestic ore situation; but this is obviously a very limited view of the case, though it has been the favorite of the conservation enthusiasts. As soon as the question of ore imports is considered, it will be seen that the entire status of the matter is changed. This is due to the fact that we have at our doors, in territory within the political and industrial sphere of the United States, ore reserves so immense as to dwarf our own domestic supplies. For our present purposes attention can be limited to the ore fields now developed along the north coast of Cuba, though as elsewhere stated there are good reasons for supposing that the ores now known constitute only a fraction of the total tonnage that will ultimately be found available in that general region. New-foundland, Africa, Brazil and Europe are equally unnecessary in the present discussion.

Limiting attention to the Cuban brown ores, we have to deal with a reserve aggregating at least three thousand million tons, of ore grading from 45 to perhaps 48 per cent iron. This can be mined, treated, and placed in the United States at a reasonable figure. The relation of these ores to the domestic supply can be summarized about as follows: At the present day steel plants located along the coast anywhere between New York City and Brunswick, Ga., could use Cuban ores profitably as compared with any possible large-scale domestic supply. Assuming that there are no serious changes in tariffs, water rates, or rail rates, it seems probable that before the average Lake ore grade falls to 45 per

cent it will be profitable to run Pittsburgh furnaces on Cuban ore. This of course involves a great decrease in the rate at which our domestic reserves will be drawn on, and a corresponding decrease in the rate at which our average grade will fall.

THE EFFECT ON PIG-IRON COSTS

As the grade of the average furnace ore gradually lowers, an increase in pig-iron costs necessarily accompanies the decreased grade. It is true that advances in technology or decreases in labor costs may operate in the contrary direction, but savings made in this way will be negligible compared with the other increases in expenses.

Lowered grade of ore means not only an increased consumption of ore, fuel, and flux per ton of pig iron, but an increase in labor, relining and overhead costs (per ton of pig) due to decreased output per day. In addition, as the ore grade lowers, it is probable that the price of ore *per unit of iron* will rise; and the price of coke will show the same tendency. These latter factors cannot be valued closely, but the increases due to increased consumption of ore, fuel and flux are definite enough. Dealing with ores of the grades now under consideration, with Pittsburgh conditions as to grade of flux and coke, a decrease of 5 per cent in the iron content of the ore involves the *additional* use of about 0.17 tons of ore, 0.12 tons of coke, and 0.36 tons of fluxing stone per ton of pig iron produced.

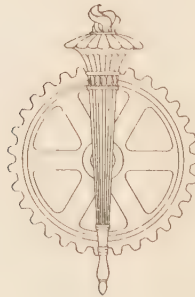
Using the data last noted, and inserting approximate current prices for the three raw materials, it will be found that a drop in ore grade from 50 per cent to 45 per cent implies an increase in cost, for raw materials alone, of about \$1.25 per ton of pig iron. When the other elements of cost, which also increase as

ore grade lowers, are considered, the total increase becomes still more serious. In addition, it must be borne in mind that the cost of coke per ton, labor per day, and iron ore per unit, are likely to increase in the future.

It is impossible to put a fair value on all of these elements of increased cost, but from those which are definitely known it seems safe to conclude that the cost of pig iron will increase at the rate of between 25 and 50 cents per ton, for each decrease of 1 per cent in the average iron content of the ores to be used. In an earlier section of this article it has been shown that the average grade has decreased almost one-half of one per cent a year, during the past twenty years or so. To combine these two sets of facts, and project the result into the future, it seems certain that the average cost

of manufacturing pig iron in the northern district will increase not less than one dollar per ton in every eight years; and that the increase may actually be double this rate. This increase will be retarded by the increased use of imported ores, but it will not be permanently checked until it has reached such a point that it is cheaper to operate the Pittsburgh and Chicago furnaces on imported ores than to bring down such Lake ores as remain.

This effect—of rising manufacturing costs—will not be due in any way to the manner in which mines or plants are owned. It will be purely an industrial phenomenon, which cannot be checked by legal or political action. The only counter balancing saving possible would be derived from improvement in concentrating methods.



COPARTNERSHIP AND PROFIT SHARING AS A SOLUTION FOR THE WAGES PROBLEM

By John B. C. Kershaw

Mr. Kershaw's article is a sequel and supplement to the papers referred to in his opening paragraph. Profit-sharing is not accepted as a scientific institution. It is a very imperfect expression of the principles of efficiency. But, perhaps because it embodies as much truth and justice as other components of our very imperfect industrial system can comprehend, it works—indeed, it seems to work better, in many cases, than systems which by all logic and even ethics are demonstrably much superior. This may be because there is involved some large psychological factor to which the schoolmen have not given a true value. In any case, profit-sharing, even if it be not the permanent best solution, may open the way to the general acceptance of other phases equally expressive of "the fair deal" and more effective in apportioning "individual efficiency reward."—THE EDITORS.

PRECEDING articles appearing in the April and May issues of THE ENGINEERING MAGAZINE, contained a strongly reasoned plea for the adoption of copartnership (or profit-sharing) principles, as the best remedy for the present industrial unrest in Great Britain, in so far as this unrest is caused by the wages problem. In the present article, it is proposed to give details of the more successful schemes of this character now operating in the United Kingdom; and to discuss finally the most hopeful methods of overcoming the obstacles that hinder the more rapid adoption of copartnership principles in the world of industry.

The difference between the fundamental principle of copartnership (or profit-sharing) and co-operative methods of production, has been explained already. Expressed briefly, it is that *copartnership* unites capital and labour; while *co-operative production* divorces capital and labour, and seeks to eliminate the capitalist from the industrial organism.

As already discovered by those who have attempted to run co-operative industries on a large scale, this

elimination of the capitalist carries with it certain disadvantages, which sooner or later bring about the collapse of the undertaking. Examples of such failures are the "North Wales Quarries"; the "National Co-operative Quarries"; and the "Coal Consumers' Pioneer Society, Ltd."; three companies, floated in North Wales about five years ago, to run mines and quarries on a co-operative basis. The failure in each case was due, so I believe, to inability to raise sufficient capital to run the mines and quarries on a paying basis.

There are three essential conditions for success in the carrying on of modern industrial operations:—(1) a plentiful supply of capital; (2) a plentiful supply of workers, skilled in the particular industry and contented with their status and rewards in the shape of wages; and (3) skilled technical and business management. Co-operative production schemes fail generally because conditions (1) and (3) are not complied with—while our present system of industry fails, because condition (2) is lacking. It is because schemes of profit-sharing and copartnership afford the simplest and most effective means for attaining, *concurrently*,

these three essential conditions of success, that I consider them worthy of special study, in this the third and final article of this series.

The principle of these schemes is not new. Copartnership was introduced and practiced in France more than 40 years ago; and one of the oldest and most successful schemes of the kind now working in England, was launched in 1889, or twenty-three years ago. Although the movement has spread only slowly, hampered as it is by the opposition of practically all the official trades unionists, there are now more schemes of profit-sharing and copartnership in operation in the United Kingdom than is generally recognized and the events of the past twelve months are likely to add largely to their number. In the following pages details are given of some of the oldest and most successful schemes of the kind:—

In the year 1889 the manager of the South Metropolitan Gas Co., a public company which shares with the Gas Light and Coke Co., the monopoly of London's Gas supply, had some difficulties with the members of the Gas Workers' Union, employed in their works. This difference led to a strike, which at the time created much inconvenience in those Districts of the Metropolis served with gas by the Company, and was marked by serious disturbances and the intervention of the military. The most important and lasting effect of the dispute, however, was the inauguration of a scheme of Profit-sharing by the Firm, and the determination to make it succeed (in spite of the opposition of the men's leaders) by dispensing with all Unionist aid and by running the Works with non-unionist labour. How successful this scheme has been, is proved by the fact that it is still

in operation at all the Works owned by the South Metropolitan Gas Company, and that 31 Gas Companies in the United Kingdom, representing 47 millions sterling (\$235,000,000) of invested capital, have adopted this or a similar principle in the management of their works.

As Earl Grey lately pointed out, when unveiling a statue of the founder of this system, in South-East London, a few months ago:

Sir George Livesey ranked very high among the men who were entitled to undying gratitude for the invaluable service they had rendered to struggling and suffering humanity. The motive which had animated him had been to promote not only the interests of himself and his fellow-shareholders, but of every worker in the company's employment. It was his achievements in the field of moral development, that would win for him enduring fame. Since the profit-sharing system had been adopted, that company's works had been an oasis of unruffled peace and brotherhood.

The South Metropolitan Gas Company's business, like that of all other public Gas Companies, has expanded enormously since the scheme was first adopted in 1889, and the Company possesses now a capitalization of over £8,000,000 sterling (\$40,000,000) and over 8,000 employees. All public Gas Companies in the United Kingdom, are granted their monopoly of supply, under a Charter of Incorporation which limits the interest that may be paid upon the ordinary share capital, and also regulates the relation between the price at which the gas is sold, and the percentage on shares. If profits increase, the shareholders not only benefit but also the gas consumer—for if the dividends go up, the price of gas must come down. What Sir George Livesey did was to bring the worker into this profit-sharing arrangement that already existed between the shareholders in the company and those

who consumed the gas, and to arrange for the payment of a bonus or percentage on all salaries and wages, this percentage rising and falling, like the shareholders' dividends, with the variations in the price at which the gas was sold. One-half of the bonus was payable in cash to the worker; the other half was used for purchase of the ordinary shares of the company, on the open market. Each worker thus became a shareholder in the company, and when his holding was large enough, the shares that had hitherto stood in the names of trustees were transferred into his own name. Up to the end of 1910, the total amount paid to the workers under this scheme had been £505,674, or an average of £24,000 per year, and of this total £276,660 had been invested in the company's business, and (as the shares are above par) the workers' holding of shares in the undertaking is now valued at £332,000.

The bonus has varied between 3 per cent and $9\frac{3}{4}$ per cent on the annual salary or year's wages of each official or worker who qualifies to share in the distribution. The bonus for the year 1910 was at the rate of $8\frac{1}{4}$ per cent, and amounted to £41,327, gas being sold to the consumer at 2 shilling 2 pence per 1,000 cubic feet, or 11 pence under the basis. The average bonus in 1910 was thus slightly over £7 per man, 5,950 workers having participated in the bonus distribution. The secretary of the company reports that they have had no trouble with the stokers, or with the trades union officials since the scheme was inaugurated in 1889, thus bearing out Earl Grey's claim, that copartnership had converted this company's works into an oasis of peace and brotherhood.

The South Metropolitan Gas Co., and another of the gas companies

practising copartnership principles, have also appointed working men on their boards of directors; the intention being to increase the number of working men representatives on the boards, as the holding of shares by the workers increases in aggregate value. This is a most valuable feature of this system of payment, since it enables the men to place their views and grievances at once, without the aid of any intermediary officials or agents, before the board of management.

Messrs. J. T. & J. Taylor, Ltd., have practiced copartnership principles at their woolen mills at Batley, near Leeds, since 1892. Though the present wave of industrial unrest in the United Kingdom has extended to their mills, and a dispute concerning price lists for certain classes of woolen goods recently disturbed the peaceful and happy relations which have existed for so long between Messrs. Taylor and their employees, this dispute must not be allowed to blind one to the advantages of copartnership, or to the fact that for twenty-one years the scheme has worked successfully in this industry. The basis of Messrs. Taylor's scheme is that the surplus profits which remain each year, after paying 5 per cent upon the paid-up capital of the company, and the usual charges for depreciation, etc., shall be equally divided between capital and labour. The share of the latter is calculated upon the year's earnings in the shape of salary or wages, and is paid in the form of shares. A double bonus is given to those employees, not less than twenty-one years of age, who have been with the firm not less than five years, and own shares in the business equal to half a year's wages. The bonus is not paid in cash, but is given in the form of fully-paid shares in the company, which receive cash

dividends as and when such dividends are declared.

Soon after the scheme was formulated, the woolen trade of Yorkshire experienced a decided set-back, and in the years 1897 and 1898 the Firm of Messrs. J. T. & J. Taylor, Ltd., had no surplus profits to divide. That the scheme survived this trying period is a proof of its soundness and of the good sense of the workpeople. Since 1898, the state of the woolen trade has enabled this firm to earn good profits, and the bonus given to the workers in the form of shares has varied from 5 per cent to 10 per cent of the year's salary or wages, while the dividends on these shares (paid in cash) has ranged from $7\frac{1}{2}$ to $14\frac{1}{2}$ per cent. The number of shareholders in the company is 1046, more than 1,000 of whom are employees of the firm. The secretary of the company reported last year that the traditionally good relations between the management of the firm and its employees have been confirmed by the existence of the profit-sharing scheme, and that their relations with the trades-union officials had also been friendly. The present dispute unfortunately discounts the latter claim, and proves once again the latent hostility of all the official trades unionists to schemes of this character. Mr. J. C. Taylor, head of the firm, is now Member of Parliament for the Batley Division of Yorkshire, and quite recently made a speech in the House of Commons in support of copartnership principles of production. The May issue of the *Contemporary Review* also contains an article on the subject from his pen.

William P. Hartley, Ltd., is a well-known firm of jam manufacturers, with works at Aintree, near Liverpool, and also near London. The profit-sharing scheme of this firm

was inaugurated in 1885, and has therefore been in operation twenty-seven years. The basis of the scheme differs from the two previous ones, in that the total amount distributed each year, also the share of each participant, is determined personally by the founder and present head of the firm, Sir William P. Hartley. The share of each worker takes the form of a cash bonus, presented by the head of the firm, at the annual gathering of the employees held just after Christmas. The total amount divided under this scheme since its inauguration in 1885 has been £66,505; while in January of the present year £5,015 was distributed amongst the workers. The firm employs between 600 and 1000 workers, mostly women and girls, and the rates of payment are rather above the standard wages of the Liverpool District for this class of labour. The head of the firm reports that there has never been any strike or labour trouble amongst the employees since the scheme was inaugurated, and that he is personally of the opinion that profit-sharing, if extended to all industries, would solve the wages problem.

Another scheme of profit-sharing practised in a somewhat similar manufacture, namely, that of sweets and confectionery, was started by the firm of C. N. & Coy, in the year 1890. The factory owned by this company is situated near London, and in the busiest season of the year 3,000 workpeople, chiefly women and girls, are employed. The profit-sharing scheme is based upon the equal division between capital and labour of the surplus profits that remain over each year, after payment of 6 per cent interest on the ordinary shares of the company. A portion only of labour's share is paid in cash; the remainder is invested as

a provident fund, from which payments are made in cases of sickness, accident, and death. This particular method of investing a portion of the bonus paid to labour will of course require revision, now that the National Insurance Bill takes care of these contingencies, and comes into force on July 1, 1912.

The aggregate share of the profits earned by this firm and paid over to labour, in the period 1890-1910, has been £158,775, the highest total in any one year being £15,750 in 1903. In 1910 the firm divided £9,500 amongst 1,881 employees, the wages list amounting to £84,000; and 62 of the girls who left to be married received the special marriage bonus of £5. This company also report that they have had no trouble with their work-people or with the union officials since the scheme was inaugurated.

The fifth example of profit-sharing is that of a large and prosperous chemical company, which has carried on the manufacture of chemicals at two centres in the North of England for many years, and in 1906 introduced the co-partnership principle into its relation with its employees. This scheme, like three of the four previously noticed, is based upon the division of the surplus profits between capital and labour, after 6 per cent interest has been earned and paid upon the ordinary share capital of the company. The scheme applies to all salaried officials and wage-earners who have been over one year in the company's employ, and whose general conduct is considered satisfactory by the directors and works managers.

The prosperity of this company has steadily increased since the scheme was adopted, the dividend on the ordinary shares advancing from 12 per cent to 20 per cent within the

period named, and the bonus to labour increasing in similar proportion from 6 per cent to 14 per cent. The bonus in this case is paid in cash, either monthly, quarterly, or half-yearly, as may be most convenient to the recipient, and each individual is free to dispose of it in the way he thinks best, no pressure being brought to bear upon the employees to make them invest any portion of the bonus in the company's shares. The managing director of this company reports that the relation of the firm with its work-people has been uniformly friendly, both before and after the adoption of the profit-sharing scheme.

The final example of copartnership principles is that of Messrs. Lever Bros., of the much-advertised Port Sunlight Soap Works, in Cheshire. This company now controls soap works and oil refineries in many countries and in both hemispheres. The company was registered only in 1894, and is therefore of comparatively recent date, but under the management of Sir William Lever it has expanded at a very rapid rate, and it possesses now a capital of over £6,000,000 and employs several thousand work-people. This company has always practised what are known in America as "welfare" principles, in its relations with its employees, and Port Sunlight in Cheshire is famous for its picturesque model village and for the many social buildings, clubs, and funds, all supported by the firm in the interests of the workers. In 1909, however, a copartnership scheme was launched, differing in some important details from the five that have been described previously in this article.

The scheme was based upon the creation of £500,000 worth of "partnership certificates," and the issue of

these certificates, as a substitute for ordinary share certificates, to those of the employees who had qualified to share in the bonus under the scheme. Every worker over twenty-five years of age, who had been five years or more in the firm's service, was qualified to become the owner of these certificates, the individual amount or share being calculated upon the basis of 10 per cent of the annual salary or wages.

These partnership certificates rank for dividend after the preference shares, and participate with the ordinary shares in the division of surplus profits, after 5 per cent has been paid on the latter. They are not transferable or marketable, and may be cancelled either through misconduct, or when the holder leaves the firm's employ. Special arrangements are made for their exchange for preference stock, when the holder dies while in the service of the firm, and leaves a widow or family unprovided for. The results of the scheme in the years 1909, 1910 and 1911 have been that £298,731 worth of these partnership certificates have already been allotted, and that £54,749 has been paid out, in interest on this investment, to the workers. The dividends paid on the ordinary shares of the company, during this period, have been 12½ per cent, 15 per cent and 15 per cent respectively, and the certificates have therefore earned 7½ per cent and 10 per cent, the latter for two years running. The number of holders of these certificates in 1911 was 1,504. This firm report that their relationship with their work-people has always been friendly, both before and since the inauguration of the copartnership scheme.

A large number of well-known firms in the United Kingdom have

carried on "welfare" work amongst their employees for many years, Messrs. Cadbury of Bourneville, Messrs. Rowntree of York, and Messrs. Calman of Norwich, being perhaps the best known of these. This system of disposing of surplus profits, though it has much in its favour, differs, however, essentially from the copartnership principle with which we are here dealing, and it is not proposed to describe these schemes in detail in the present article. I regret that I cannot give any example of copartnership principles, in operation in the United Kingdom, in connection with large engineering or shipbuilding undertakings.

Messrs. Armstrong Whitworth & Co., of Newcastle, inaugurated a scheme in 1897, and some details relating to this were given in an article published in this magazine in June, 1903.* The scheme appears however to have failed, and a similar fate has overtaken that introduced by Sir Christopher Furness, at the well-known Shipbuilding Firm of Messrs. Irvine at West Hartlepool in April, 1908. This scheme was rejected by the workers after only twelve months' trial, on the somewhat illogical grounds that work was irregular and profits small.

The fact that all the successful schemes of copartnership dealt with in this article, with one exception, are practised by firms which employ unorganized or non-unionist labour, shows however that the real cause of the non-success in other cases is the hostility of the labour unions and officials, and that could this opposition be overcome, there would be a wide extension of the copartnership principle in all the highly-skilled and organized industries. This brings up the important question of the methods by which the usual trades-

* "The Promotion of Industrial Efficiency," by J. B. C. Kershaw.

union attitude of hostility towards the principles of copartnership production can be changed to one more friendly, since the future success of these schemes in the United Kingdom depends largely upon placating trades-union opinion.

My plan for attaining this much desired change of attitude is set forth in the following extract from a lengthy article which I have prepared for publication in the *Fortnightly Review*, upon "The Future Relations of Capital and Labour in the United Kingdom."

"In order to obtain the support of the trades-union leaders and officers, the writer suggests that the present anomalous system by which the men's leader's income and influence is dependent upon the amount of disturbance he can create in any industry, should be ended. To attain this much needed reform the men's leaders in each branch of the industry where copartnership principles have been adopted, should be admitted as the men's representatives on the boards of management of the larger companies, and should draw the usual fees for their work, as directors of the company. This is not a wholly impracticable proposal, for the South Metropolitan Gas Co. has already three workingmen directors on the board, and some of the other companies which practice profit-sharing are now considering the wisdom of making similar appointments. The effects of such a policy would be great and far-reaching. The trades-union leaders would have a fixed income, which would not be dependent upon their ability to produce discord. As directors of large industrial companies, they would learn to understand some of the difficulties of conducting modern manufacturing businesses on paying lines. As Mr. Balfour well said in his Presidential Address before the Labour Copartnership Association in 1908; these men would gain 'the most intimate knowl-

edge possible of business methods, business difficulties, business risks, and business profits.' With this knowledge in their possession, they would recognise more clearly than at present the losses that result to all classes of the community from strikes and industrial turmoil; and the opportunities afforded by the weekly or monthly board meetings would render unnecessary a resort to the barbarous methods used today, for obtaining a hearing for the workers' grievances, either as regards rates of pay or hours of work.

"That this creation of workingmen directors would at once overcome all trades-union hostility to schemes of profit-sharing and copartnership, the writer does not contend; but he believes that it would have considerable influence in this direction, and would smooth the path for the introduction of these schemes in many industries."

This recognition of and provision of an income for the men's leaders, must be allied with another concession that is essential for the smooth working of profit-sharing schemes under the existing conditions of manufacturing industry, and that is, the recognition of the trades-union rates of wages in each industry.

Unless this payment of the standard rate of wages is agreed upon, there is little chance that schemes of copartnership can be widely adopted in the general engineering and more highly-skilled industries in the United Kingdom, for there would always be a grievance on the men's side, that they had not been fairly dealt with when the scheme was inaugurated. The payment of the standard rate of wages for labour is in fact as essential to the success of these schemes as the fixing of a standard rate of interest for capital.

These rates will of course vary with the character and risks of the

particular industry or manufacture, and may be altered from time to time by mutual arrangement and consent. In the schemes dealt with above, the trades union rates of wages, or a higher rate, have been paid in each case, and the return upon capital has been fixed at 5 per cent or 6 per cent. Certain industries, however, where the financial risk is greater (as for example that of mining) would require to offer a higher rate of interest than 6 per cent to attract capital, and here the limit might be fixed at 10 per cent or 15 per cent. After the payment of this interest on the ordinary share capital, labour would begin to share in the surplus profits.

CONCLUSIONS

The opinions expressed in this article may be summarized as follows:—

(1) The profit-sharing or copartnership principle has been shown by numerous examples, extending back twenty-one years or more, to be a practicable and successful method of settling the relations between capital and labour.

(2) The base principle of the majority of these successful schemes is, that every worker with over twelve-months' service to his credit in the employment of the firm by whom he is engaged, shall be given a direct share in the profits of the business, *over and above his payment by wages*. This share, or bonus, must be based on the amount of his annual salary, or earnings in the form of wages, and must be paid out of the surplus profits remaining after the usual charges have been met, and a fair and reasonable fixed rate of interest has been paid on the ordinary share capital of the undertaking. Capital and labour must share equally in this further distribution of profits. The workers' share of the

surplus profits must be paid over in cash, at stated periods of the year, and there should be a regulation that some portion of each payment shall be invested in the business, either as loan-capital or by purchase of shares.

(3) In order to overcome opposition of the trades-union leaders to copartnership schemes of production it should be a condition of the introduction and acceptance of such schemes, that trades-union rates of wages are recognised, and that as soon as the worker's financial stake in the business is sufficiently large, one or more of the union leaders shall be placed on the boards of management, in every industry.

With the concessions to trades-union opinion outlined in (3) (which I believe to be just) I consider that there is a great future before copartnership production, and that by development of our industries along these lines, we may expect to overcome those special difficulties which at the moment hinder the harmonious co-operation of capital and labour.

That I am not alone in thinking that copartnership production will assist in solving the labour problem, is proved by the widespread interest which is being taken in the subject at the present time, and by the following extracts from speeches delivered by Earl Grey and Lord Robert Cecil, at the unveiling of the memorial to one of the pioneers in this movement (Sir George Livesey) in East London, in December, 1911:—

The value to the country of a wide adoption of copartnership principles, no one, however vivid his imagination, could venture to measure. Owing to the experiment of the South Metropolitan Gas Company, there was a new light upon the mountain tops. If others were wise enough to follow the lead which Sir George

Livesey had given them, he predicted that this country would have great prosperity, and that the workers of the next generation would make as big a step forward as did the middle classes in the last.

EARL GREY.

The co-partnership system held the secret of the solution of our industrial problems, if any solution was to be found. Co-partnership was not merely profit-sharing; it also represented a sharing of the capital and a sharing of the responsibilities. It was by the adoption of that principle in the industrial life of this country, that we might seek and hope to secure a peaceful issue, of the present threatening condition of affairs.

LORD ROBERT CECIL.

But it may be asked, what is to be done if the labour unions and their leaders still maintain their implacable attitude towards all schemes of copartnership, and decline to accept the concessions outlined in this article, as an olive branch held out by the employers in the cause of industrial peace?

If this attitude be adopted then only one course remains open. It is to rally all the more sober-minded and level-headed working-class opin-

ion in the country to the side of the masters; to found new labour unions, under wiser and more reasonable leadership than those now existing; and to employ only those workers who have enrolled themselves as members of the new unions.

In conclusion, I would deprecate undue pessimism or despondency about the future of manufacturing industry in the United Kingdom. Though for the time the spirit of unrest and turbulence is abroad, and the labour agitator and mob orator appear to be supreme, this mood will pass away, and a more reasonable spirit will come to the surface in the labour world. We may hope that when this time arrives, some trusted leader will appear who is able to guide the desires of labour into more reasonable channels; and that by the general adoption of schemes of copartnership as outlined in the earlier portion of this article, the relations of capital and labour may be smoothed; strikes and lock-outs may be banished from our midst; and employers and employed once again may work in harmonious co-operation for their mutual advantage, and to the benefit of the general community.





CONSTRUCTION CAMP, HIGH-TENSION LINE FOR THE BERNINA RAILWAY

THE BERNINA ELECTRIC RAILWAY

By C. Van Langendonck

ONE of the routes most favored by excursionists in Switzerland has always been that which leads from St. Moritz by way of Pontresina in the Canton of the Engadine to Tirano in the Canton of Valtelino through the Bernina pass.

In 1900 a railway line was built completing the southern section from Sondrio to Tirano. A few years later a second section running from St. Moritz to Pontresina on the northern side was opened, these two sections being operated first by steam.

The new Bernina electric railway runs from St. Moritz to Sondrio. It connects and links together the two sections first built and offers a new way of communication between eastern Switzerland and the Italian

cities of Lombardy, and ultimately Venice.

The Bernina line is one of the most important and most picturesque of Switzerland. Technically, it is interesting in that it depends upon adhesion only for its entire length, although the difference of level between its point of highest altitude is greater than that of any Swiss rack road. Scenically, it offers to the tourist a marvelous succession of panoramas, unmatched anywhere else.

Leaving St. Moritz at 1,772 metres above sea level, the line follows the gorges of the Inn, passes through a tunnel 700 metres long, and drops into Pontresina by a great curve. Thence it continues along the west side of the bottom of the steep valley



LOOP IN THE LINE NEAR CAVAGLIA

to the famous glacier of Monterat, where it turns toward Montivello through the Bernina pass, which it traverses close to the lakes situated near the Hospice de la Bernina. The line then strikes easterly toward the Val de Lagone, following the shores of the lakes, and soon reaches its

highest point—2,256 metres above sea level. Descending, the line traverses the Val de Pila, curves along the Gröunalp in the immediate neighborhood of the Palu glacier, crosses the plateau at Cavaglia, and, curving again, strikes toward Poschiavo. Here the line again takes to the bot-

THE WORK OF THE SNOW PLOUGH

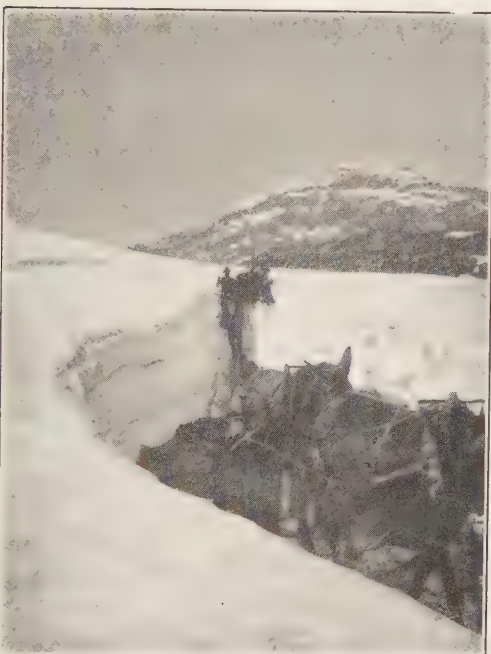


tom of the valley, rejoining the roadway, which it follows to the lake of Poschiavo, and then descends by steep grades past Brusio, Campaccio and Campocologno to its terminal station at Tirano, 429 metres above sea level.

The total length of the line is 60.6 kilometres. At the northern end, the difference of altitude between the starting point at St. Moritz and the summit near the Hospice de la Bernina is 478 metres in a distance of



THE BERNINA LINE IN WINTER



HAULING MATERIAL FOR THE HIGH-TENSION LINE

22.3 kilometres. At the southern end, a drop of 1,827 metres is accomplished in a distance of 38.3 kilometres. The line thus climbs a longer and more important grade than any rack railway in Switzerland. Indeed, the four principal Swiss rack railways are the Wengernalp, a total climb of 1,264.7 metres; the Gornergrat, 1,411 metres; Mount Pilatus, 1,628.45 metres; and Brienz-Rothorn, 1,681 metres. The maximum grade is 7 per cent, continuing for a distance of 18 kilometres from

Poschiavo to the Hospice. Altogether, 27 kilometres of the line have a 7 per cent grade. At the stations a low grade of 1 per cent is secured for a length of 80 to 95 metres. Curves, whether in tunnel or in the open, have a minimum radius of 50 metres. Altogether there are five tunnels on 50-metre radius curves, and seven larger tunnels, of which the principal, as stated above, is 700 metres long. Beyond this, many structures were needed, such as bridges and viaducts, these last sometimes reaching considerable height.

The current for the entire line is furnished by the Campocologno station, which is situated about four miles from Tirano, and is a subsidiary of the Brusio installation described in THE ENGINEERING MAGA-



TRANSPORTING POLES FOR THE HIGH-TENSION LINE



GRIM STATION



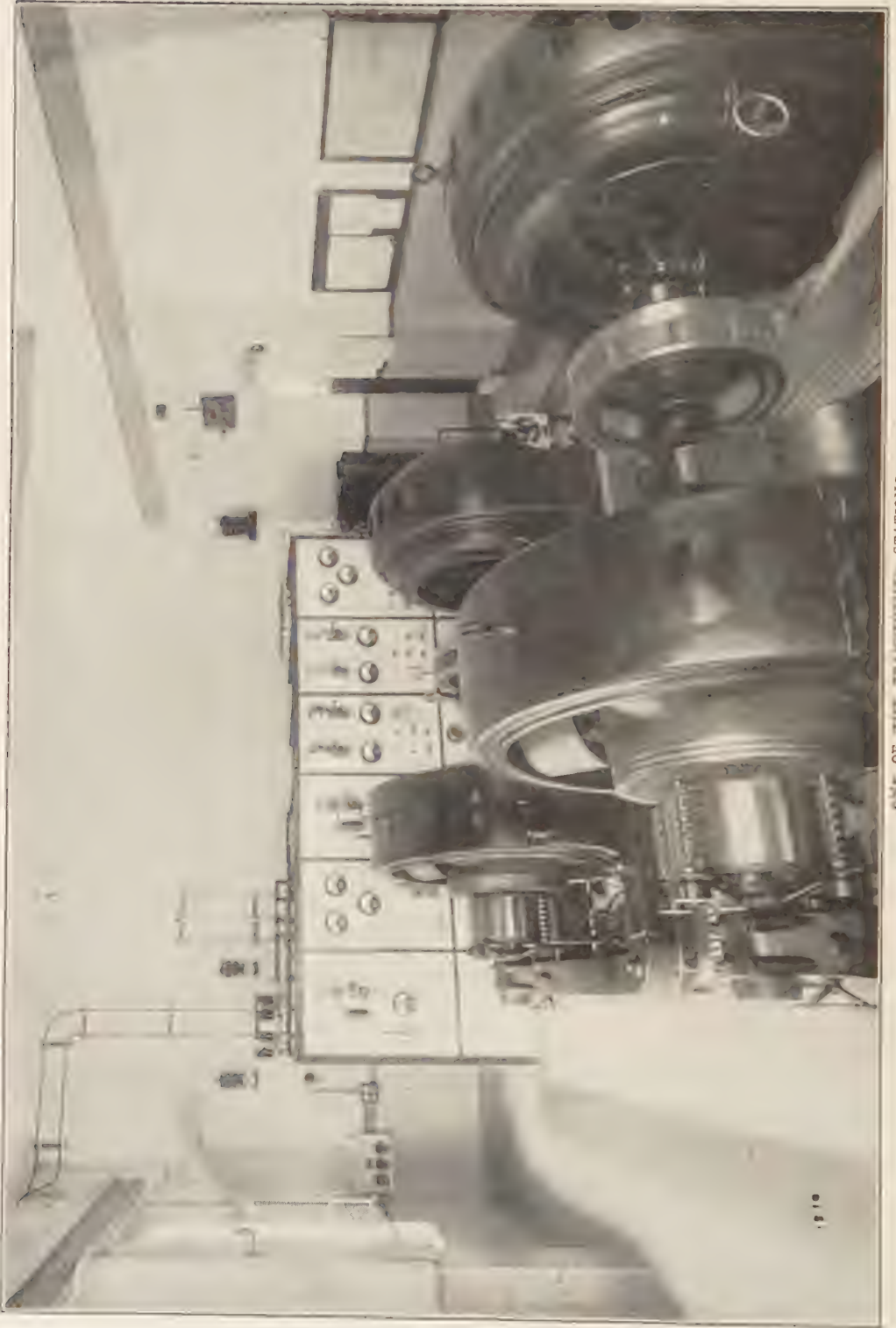
THE PALMISTON COAST FROM THE AIR



STATION AT HOSPIZ



THE STATION, ST. MORITZ



ONE OF THE TRANSMISSION STATIONS

ZINE for November, 1908. A reserve station is at Poschiavo.

The current from the Campocologno central station is tri-phase, 7,000 volts, 50 periods. The railway line uses continuous current at 750 volts. The high-tension current from the central station is transformed at four substations scattered along the line. The three-phase high-tension current goes first to the primary sub-station, situated only 200 metres away, over a high-tension line. Here, part of the 7,000 volt current is reduced to 500 volts, and then transformed into 750-volt direct current. The rest of the current received from the central station is raised three-phase, 23,000 volts, and conducted over a long-distance line to the other three sub-stations, which are 15 to 20 kilometres apart. The high-tension conductor takes the shortest line from station to station. It connects the sub-stations together, and is itself connected to the reserve station at Poschiavo. It is composed of three conducting wires, 6 millimetres in diameter each, arranged in a triangle, 80 centimetres apart, and carried on wooden poles 11 metres high. Steel poles are installed at road crossings. At each sub-station the high-tension line is equipped with two interrupters, one to cut the sub-station out of the circuit, and the other to cut out the remainder of the line. At the Poschiavo station, also, two interrupters are installed so that this station can serve the entire network or the right or left branch alone.

The construction of the high-tension line was a very difficult undertaking. As it crosses the mountain, heavy labor was involved in carrying up the poles, the cement, and other materials to the places where they were to be used. Tent camps were set up at various places to shel-

ter a force of about ten workmen and special services were organized to carry up materials and supplies. Most of this had to be done on mule-back, and often working roads had to be opened in the snow to cross the water courses and through the forest.

Three of the sub-stations are similar. Receiving three-phase current at 23,000 volts, they lower it to 500 volts, and then transform it into continuous current at 750 volts. The fourth sub-station, that at Campocologno, as already explained, serves two purposes. For raising the 7,000 volt three-phase current to 23,000 volts, it has two transformers of 900-kilowatts capacity each. The normal equipment of the four sub-stations is two transformers for three-phase current, 23,000 to 500 volts, and two continuous-current transformers, each consisting of an asynchronous three-phase motor of 275 horse power directly coupled to a direct-current generator of 185 kilowatts. There is also an accumulator battery of 390 elements, with a capacity of 333 ampere hours.

The contact line throughout its length is composed of two hard-drawn copper wires of 9 millimetres diameter, giving a total section of 127.2 square millimetres. At certain places supplementary feeder cables of 2 by 120, 2 by 100, or 2 by 70 square millimetres are provided. The section of the conducting wires has been calculated for a maximum loss of tension of 16 per cent, in the case of a 45-ton train at the most unfavorable point between two sub-stations. In the open the contact line is suspended from bracket arms fixed to wooden posts. On curves in the open, the same system of suspension is employed, but the posts are reinforced. The aerial wire is double insulated. In the principal stations



VIADUCT NEAR BRUSIO

suspension is from transverse supporting wires, which are themselves supported by a second sustaining wire of considerably deeper catenary so as to afford absolute security. Suspension in tunnels is from transverse wires anchored into the arch.

The distance between the contact wire and the right of way is from 5.2 to 5.6 metres. At road crossings this is increased to 6 metres, and at station areas to 6.25 metres, but in tunnels it is reduced to 4 or 4.15 metres. The distance between supporting poles is 30 metres on the straight, but is reduced to 12 metres on curves.

The rolling stock comprises a total of fifty-nine carriages, of which fourteen are motor cars for passengers, sixteen are passenger trailers, two mail cars, and twenty-seven freight and baggage cars.

The passenger motor cars are

four-axle, double-bogie. The platforms are completely enclosed. They can carry seated thirty-one third-class passengers, and twelve second-class passengers, and they have lavatory and toilet. On each of the four axles of the motor trucks is mounted a motor of 75 horse power normal at 550 revolutions.

The carriages have, furthermore, electric lighting and heating. The four motors are capable of driving a 45-ton train at a speed of 18 kilometres an hour on a 7 per cent grade. The weight of the motor carriages is 28 tons.

The freight cars have two axles and two motors and are equipped with only half as much power as the passenger cars. The weight of the passenger trailers is 8.5 tons, and each is provided with two brakes. The construction of the whole line was completed in four years.

THE RELATION OF CAPITAL, LABOR, AND EFFICIENCY IN MANUFACTURING

By A. G. Popcke

Mr. Popcke's analysis of the Census statistics brings out a point of vital importance both to employers and employes. It is that the margin available for increase either of wages or profits in manufacturing enterprises is progressively diminishing because of the continual increase in the proportionate burden of expense. The only salvation, whether for owners or workmen, is co-operation to reduce the cost of production by eliminating wastes and increasing efficiency, and practical, constructive measures for accomplishing that purpose are suggested.—THE EDITORS.

INDUSTRIAL establishments are in business to make a profit. The desire of the stockholders is to make the percentage of return on their investments as large as possible. Every shop manager knows that it is more difficult to meet competition now and make money than it was ten years ago. Why is this, and how can conditions be improved?

To make a given percentage on an investment at all times, the net profit must increase in the same proportion as the capital invested. Progress and prosperity are produced in any period of time when the net profits increase at a greater rate than the capital invested. The net profit on any article is equal to the selling price minus the total cost of producing it. Its selling price is set by market conditions; except in the case of a monopoly, it is the average selling price set by the various industries engaged in the manufacture of the same article. The total cost of producing an article in addition to the cost of materials is the sum of the labor, salaries of officials, supervisors and clerks, cost of maintaining the plant and equipment, and fixed charges (interest and depreciation) on the investment.

The management of an establishment are responsible for the total

cost of producing an article; they are also largely responsible for the capital invested, because one of their functions is to select the equipment required to carry on the processes of manufacture. For this reason, the policy of a management is responsible for the percentage of returns on an investment. They are in a position to bring about harmony between capital and labor.

Figures obtained by an analysis of the United States Census of Manufacturers bring out many interesting facts showing relations between capital and labor; and study of these data suggests measures for obtaining harmony between these two parties which will result in greater efficiency of operation, an advantage to both. General conclusions can be drawn from data of this kind which will show average conditions accurately, though they may not apply to every individual case. Consider the mortality tables; they are the basis of life insurance. A mighty business is in this case based on data of average lives; the life of any one person is very indefinite and cannot be controlled. An industrial establishment is under human control—therefore, a study of average conditions will show how they can be improved by proper control.

TABLE I. ANALYSIS OF U. S. CENSUS DATA

	Total	Number or value per		
		Establish't	Wage Earner	
No. of Establish- ments	1909....	268,491	.....	.....
	1904....	216,180	.....	.....
	1899....	207,514	.....	.....
No. of Wage Earners	1909....	6,615,046	24.6	.....
	1904....	5,468,383	25.2	.....
	1899....	4,712,763	22.8	.....
No. of Salaried Employees	1909....	790,267	2.96	.12
	1904....	519,556	2.3	.095
	1899....	364,120	1.76	.077
Primary horse power to operate establishments..	1909....	18,680,776	69.4	2.82
	1904....	13,487,707	62.4	2.46
	1899....	10,097,893	48.7	2.03
Capital	1909....	\$18,428,270,000	\$69,000	\$2,780
	1904....	12,675,581,000	85,500	2,310
	1899....	8,975,246,000	43,200	1,900
Salaries	1909....	\$938,575,000	\$3,500	\$142
	1904....	574,439,000	2,670	105
	1899....	380,771,000	1,840	81
Wages	1909....	\$3,427,038,000	\$12,800	\$520
	1904....	2,610,445,000	12,100	478
	1899....	2,008,361,000	9,650	427
Cost of Materials.	1909....	\$12,141,791,000	\$45,300	\$1,830
	1904....	8,500,208,000	39,300	1,560
	1899....	6,575,851,000	31,700	1,390
Value of Products.	1909....	\$20,672,052,000	\$77,000	\$3,130
	1904....	14,793,903,000	68,500	2,800
	1899....	11,406,927,000	55,000	2,420
Value added by Manufacture ...	1909....	\$8,530,261,000	\$31,700	\$1,300
	1904....	6,293,695,000	20,200	1,240
	1899....	4,831,076,000	23,300	1,030

* Salary per salaried employee.

Table I contains data covering the average of all the manufacturing industries in the United States for the years of 1909, 1904, and 1899. Although the Census report states that some of these figures, particularly that of capital, are somewhat defective, they serve to indicate general conditions.

For analytical purposes, these items have been figured on the basis of number and value per establishment and per wage earner. Tables II and III show the percentage by which the various analytical quantities of Table I have increased in the last ten years. A study of these tables shows:

(1) Number of employees—wage earners and salary earners.

In the average establishment, the number of wage earners has increased 8 per cent, whereas the salaried employees have increased 68 per cent. The excessive increase in employees obtaining salaries, including supervisors, clerks, and salesmen, is due to the increased complications in business methods in manufacturing departments of establishments requiring more clerical work, and due also to the necessity of larger sales forces to meet the more severe competition. This fact has increased the overhead charges in industrial

establishments, increasing the total cost of their products.

(2) Wages and salaries.

The wages have increased at a greater rate than the number of wage earners. Wages per establishment increased 33 per cent, the average wage earner having obtained an increase of 21.5 per cent.

TABLE II. PERCENTAGE INCREASE OF THE COMPONENTS DETERMINING THE ECONOMIC CONDITIONS OF AN INDUSTRIAL ESTABLISHMENT INCREASE PER ESTABLISHMENT

Item	Per cent Increase per Establishment from 1899 to 1909
No. of wage earners.....	8
No. of salaried employees.....	68
Primary horse power.....	42
Capital	60
Salaries	90
Wages	33
Cost of materials.....	43
Value of products.....	40
Value added by manufacture....	36

The salaries per establishment have increased 90 per cent; per salaried employee, they have increased 68 per cent in the average industry. This shows that the salaries have not increased in the same proportion as the wages, indicating the decrease in responsibility of the majority of salary earners. The tendency is to use cheap clerks in order to cut down expenses. The relative ratio of salaried employees to wage earners has increased from 7.7 per cent to 12 per cent, an increase of 55 per cent in the past ten years.

(3) Capital and value of products.

The capital per establishment has increased 60 per cent. The value of products has increased 40 per cent, and the value added by manufacture has increased 36 per cent. In other words, the capital required to produce a given value of product has increased 24 per cent more than the value added by manufacture, or the fixed charges have increased in greater proportion than

the net profits; the net profits are proportional to the value added by manufacture. The Census does not give any direct indication of the net profits. The large increase in capital has been necessitated by the frequent changes in the processes of manufacture brought about by the invention of new labor- and time-saving machinery. The increase of 43 per cent in the horse power required to drive the machinery is a criterion of the increased investment required for machinery and power-generating equipment. All these improvements are necessary to keep an industry up to date, and must be paid for. The interest and depreciation on these investments have increased the cost of products. The cost of materials has increased 43 per cent, approximately at the same rate as the value of the products.

The above analyses show why the overhead charges and fixed charges of an establishment have increased, making the margin of profit smaller.

TABLE III. PERCENTAGE INCREASE OF THE COMPONENTS DETERMINING THE ECONOMIC CONDITION OF INDUSTRIAL ESTABLISHMENTS INCREASE PER WAGE EARNER

Item	Per cent Increase per Wage Earner
Primary horse power.....	39
Capital	46
Salaries per wage earner.....	75
Salaries per salaried employee..	13
No. of salaried employees.....	55
Wages	21.5
Cost of materials.....	31
Value of products.....	29
Value added by manufacture....	26

Some interesting conclusions can be drawn when studying the figures in Table III.

(1) Relation of increase in wages to increase in value of products.

Wages have increased an average of 21.5 per cent per wage earner. The items represented, to which the increase in the cost of living is proportional, are:—

1. The value of products, which has increased 29 per cent.

2. The value added by manufacture—increased 25 per cent.

3. Cost of materials—increased 31 per cent.

Labor should be paid for its services in proportion to the net profits; therefore, the percentage increase of each should be in the same proportion.

All these show that labor agitations for increased pay are justifiable, because the reward for labor has not increased in proportion to either the cost of living or the net profits produced by their services.

2. Capital per wage earner.

Capital invested per wage earner has increased 46 per cent—as stated before—largely because of the use of up-to-date machinery, indicated by 39 per cent increase per wage earner for the horse power to operate equipment.

All these improvements have increased the overhead and expenses other than direct labor in the plants. This has made capital fight against increased wages, because the greater expenses have made it more difficult to meet competition and to make money. Unless the increased capital is due to “watering stock,” capital is justified in its position. The increase in capital seems logical, however, when we consider the large increase in power required to operate increased machinery equipments.

The analysis just given shows that both labor and capital have logical reasons for their stand.

The question arises—What can be done to remedy these conditions? The answer is that capital and labor should co-operate and do all they can to decrease the overhead and fixed charges and other expenses of operation. That is, wage earners should help all they can in operating ma-

chinery, so that work is done economically in the least possible time, and should help in reducing all unnecessary wastes in manufacturing to a minimum. This is the object of those engaged in efficiency engineering, and if they work along the proper lines they will do much to improve industrial conditions. They should deal only with the elimination of wastes, the obtaining of maximum economy from equipments, improving physical and mechanical conditions (as by simplifying methods of handling materials, simplifying clerical work, and the like) rather than deal with labor directly. The latter usually results in labor troubles which cancel all savings obtained by the other means.

Labor unions tend to reduce the efficiency of operation because they limit the work that can be done in a given time with a given investment, thereby increasing the fixed charges which in turn decrease the possibilities of increasing wages. They are defeating the very results they are seeking.

The use of a large number of cheaper clerks is also a step in the wrong direction; this practice increases the errors made which cost money. This money comes out of the net profit. This practice has established complicated systems, under which it is difficult to place responsibility on any one person. Complicated systems are eliminated by employing responsible clerks, they will do work faster and far more accurately at a smaller total payroll than a lot of slovenly, easy-going individuals who seek an easy job requiring no responsibility.

Capital and labor should co-operate and with the aid of efficiency engineers should make a scientific investigation to determine whether or not all the components upon which econ-

omy of an industrial establishment depend are at their maximum efficiency. These components can be summarized as follows for any industrial establishment:—

1. Proper routing system, involving:—

- (a) Location of machinery.
- (b) Storing and moving materials to and from machines with overhead cranes, industrial railways, trucks, jib cranes, or by hand.

2. Proper handling of materials at the machines:—

- (a) Putting work in or removing work from machines with main crane, jib crane, other mechanical means, or by hand.
- (b) Performing the work, involving:—

- 1. Application of power.
- 2. Speeds.
- 3. Facilities for making adjustments.
- 4. Proper records of all details.

3. Proper light, ventilation, heating and sanitary conditions.

4. Proper source of power:—

- (a) Generated in the industrial plant.
- (b) Purchased.

5. Proper records of the costs and operating details of 1, 2, 3 and 4.

The following are suggestions for carrying out this co-operative work in industrial establishments.

It is good policy for a management to encourage meetings of shop men at which members of the management give a series of talks explaining general conditions that exist, bringing out points similar to those discussed above. In addition, each of the items of the above outline can be used for discussion. Besides foremen, there should also be

present at these meetings representatives of workmen, including the more intelligent and those having influence over their co-workers. This will help carry out in a harmonious way ideas and conclusions drawn at the meetings. The use of a suggestion box will also help bring out existing defects.

The following are suggestions for methods of increasing the efficiency of each of the components enumerated above:

(1) IMPROVING THE ROUTING SYSTEM.—All machines should be independent units so they can easily be placed in any position to suit the progress of work. In many shops at the present time machines are placed to suit line shafting; the routing system is often complicated on this account. By using a motor on each machine, in many cases, the machines are not handicapped by this limitation of position. This question involves co-operation of management and efficiency engineers, who are well acquainted with methods of electric-motor application. In a factory making nuts and bolts, for instance, hot heading machines were arranged to suit a line shaft. It was found that turning the machines at right angles to their original position made it possible to place 50 per cent more machines in a given space. To do this with line shafting meant many overhead complications; a motor on each machine was necessary, and made possible the use of overhead cranes which cut the cost of handling materials in two by the simplification of the routing system.

Operators of machines are often delayed by defects in a routing system. They must wait for tools and materials; the management, in large plants especially, do not know that such conditions exist and the operators are usually afraid to criticise

this defect. Co-operation between the two parties and efficiency engineers will solve a method of overcoming this defect. Labor sees and has experience with the defects and can in most cases suggest remedies for them.

(2) PROPER HANDLING OF MATERIALS AT THE MACHINES.—It is here that labor can point out many defects if a management co-operate with them. Workmen often complain about a machine not being adapted to do certain work. If this is the case, an investigation should be made by an efficiency engineer to see whether the defect actually exists, and if it does, he should give a remedy. In this connection, if a machine is motor driven, a graphic recording meter applied to it will sometimes show many defects (see paper by Chas. Robbins, *Transcriptions*, A. S. M. E., April, 1910). The meter shows not only the power required, but also the time needed to do the various operations. All those who have used this method will agree that, being automatic, it shows all conditions without prejudice. Labor is often ignorant of the possibilities of a certain equipment. Using a meter of this kind sometimes causes antagonism of labor because they look at it as a check on them and a method of reducing time or piece-work limits. Tests show that in the majority of cases the defects causing delays are in the routing system and characteristics of the machine used; these defects can usually be improved by slight modifications. By co-operation with labor the meter can be used without antagonism. Also where premium and piece-work systems are employed, dissatisfaction, which breeds inefficiency, exists because of unfair time limits due to setting by incompetent parties or defective equipment. The graphic meter method is an excellent means of setting a limit be-

cause it shows average conditions over several days operation. Limits set by use of stop watch and observing a few operations are usually inaccurate.

(3) ILLUMINATION.—Proper light is necessary if work is to be done efficiently. The application of the tungsten lamp has increased the efficiency of lighting considerably. An interesting fact to bear in mind is that the friction load of line shafting far exceeds the power required for lighting. Many tests made on line-shaft driven shops show that if the total friction load is divided by the total number of machines, the result expressed in watts averages between 200 to 300 watts. What good illumination one 250-watt tungsten lamp placed over each machine in a machine shop would make! If each machine were driven by an individual motor, the saving in power would be equivalent to the power consumed if this were done. A superintendent usually calls down a man if he leaves a 16 candle-power drop lamp burning in broad daylight. This consumes only 50 watts. The use of belts also increases the amount of light required, and when tungsten lamps are used increases the maintenance cost of more frequent cleaning of reflectors. Shop managers are usually afraid to supply too much light. A little too much light does no harm; but too little light has a depressing effect on those who must work by it.

The majority of modern plants are taking steps to improve their ventilation, heating and sanitary conditions.

(4) SOURCE OF POWER.—Large investments are often made for power generation before a thorough investigation of power requirements has been made. Expensive electric plants are installed, which increase the fixed charges on the entire establishment, where power could be purchased more economically. Large central

stations are realizing the importance of power day-loads and are taking steps to develop their business along these lines; many of them are, therefore, selling power at rates equal to and less than it costs large industrial establishments to make it. Industrial establishments when figuring the cost of power often omit investment charges such as interest and depreciation, and are deceiving themselves when they figure power is only costing them from $\frac{1}{2}$ to 1 per cent per kilowatt hour. Here again a careful investigation should be made, the management co-operating with an efficiency engineer who is competent to deal with the power question. In a railroad shop, where all the machinery was driven from line shafting driven by steam engines or by individual steam engines, and 70 per cent of the steam was used for other purposes such as heating, running air compressors, pumps and steam hammers, the installation of an electric plant, turbine-driven, was considered. The investment for the necessary motors and turbine, switchboard, etc., was \$35,000. If central-station power were used, \$11,000 would have covered the investment for motors. The total net saving, figuring fixed charges on investments, in the first case amounted to \$1,582 per year, or 4.5 per cent on the \$35,000 investment, whereas if power were purchased at 2 cents per kilowatt hour, the net saving per year amounted to \$2,138, or 19.5 per cent on the \$11,000 investment. The steam for miscellaneous purposes remained unchanged. Instead of investing \$24,000 in power generating equipment, the efficiency of shop equipment could be greatly increased by an equivalent investment therein.

(5) PROPER RECORDS.—It is necessary to have proper co-operation between capital and labor to obtain ac-

curate records. Graphic meters of various kinds, and responsible clerks, increase the reliability of records. These records guide the management when they make changes; their importance is therefore self-evident.

Shop managers and superintendents often state that they are in touch with all the details of their shops. Experience with graphic recording meters shows that even foremen are ignorant of many detailed defects. An efficiency engineer makes a business of observing defects, and one proficient in his work will see how principles discovered on previous investigations in an entirely different industry can be applied to advantage in a case under consideration. He looks at a proposition from many points of view, whereas a foreman or shop superintendent, busy with many minor details of routine work, has not so general a view of the situation. For this reason an outsider, knowing less about a business than one engaged in it every day, will be in a position to apply original ideas which were never thought of by one who sees the same things every day more or less from one point of view.

There is a large field in which to make improvements and reduce the gradually increasing overhead and fixed charges. Those plants whose managers are willing to have capital, labor and efficiency co-operate will succeed in increasing the margin between total cost and selling price, increasing the net profits, and the dividends to their stockholders.

In a plant in which steps are taken to make the components upon which shop economy depend the best possible, the moral effect upon all operators is to do everything just right. Everybody will be satisfied, and satisfaction produces confidence which is the basis of efficiency.

POWER MACHINERY OF THE STEEL INDUSTRY

By Robert L. Streeter

II. BLAST FURNACES

Professor Streeter's series began in our August issue with an article surveying ore-mine hoisting machinery and compressor plant. Following portions will take up rolling-mill engines, coke-oven machinery, general power units, and electric generators and motors. The viewpoint throughout is from the driving rather than from the driven end, and considers economy of operation and influence upon cost of production rather than mere mechanical detail.—THE EDITORS.

POWER is used in blast-furnace work principally for furnishing compressed air for the blast, hoisting limestone, coke, and ore to the top of the furnace, for operating furnace bells or hoppers, and for pumping cooling water. In any blast-furnace plant all this power can be generated by using the excess gas that comes from the furnace. Up to about 1903, in the United States, this gas was always burned under boilers, and steam engines were used entirely for furnishing the power. These power plants were often crude affairs, the engines and boilers being housed in sheet-iron or board sheds with just enough shelter to keep the pipes from freezing in cold weather. A blast furnace is a dusty proposition at best, and the machinery usually suffered greatly from the dirt.

Up until about 1840 charcoal was used almost exclusively for blast-furnace fuel. Furnaces were built low and blast pressures were only five or six pounds per square inch, as the pressure depends entirely on the height and diameter of the furnace. One of the first men to try anthracite coal for furnaces was Mr. Kunzie of the firm of Farr & Kunzie, manufacturing chemists of Philadelphia. While Mr. Kunzie was doing his experimenting, Mr. David Thompson built a furnace using coal

for fuel for the Crane Iron Company at Catasauqua, Pa., which was very successful. This was really the first furnace to use mineral coal on a commercial basis. Later Mr. Kunzie built a furnace for using anthracite coal for fuel, on the Schuylkill River, about twelve miles from Philadelphia. This furnace gave much trouble right from the start, and it was not until Mr. Reeves of Philadelphia purchased it and had it remodeled by Mr. John Fritz, about 1852, that the furnace was really successful.

It was not until the iron-manufacturing zone moved westward out of the anthracite coal regions that coke was used for blast-furnace fuel. The Cambria Iron Works was one of the first plants to use coke furnaces, about 1852. Those furnaces gave a great deal of trouble, due probably to the iron pyrites in the coal. The sulphur from the pyrites would remain in the coke, and in the blast furnace would be transferred to the iron, making it almost worthless for rolling. Today only the best coal is used for making blast-furnace coke, and where sulphur greater than 1 to 1½ per cent is present in the coal it must be washed out before the coal can be used.

The third and fourth furnaces of the Bethlehem Steel Company at Bethlehem, Pa., were built in the



FIG. 19. LOCOMOTIVE CRANE LOADING PIG-IRON WITH AN ELECTROMAGNET
Electric Controller & Manufacturing Co.

early seventies. These furnaces were 70 feet high and 17 feet in diameter at the bosh the largest in use at that time. The fuel used was anthracite coal and the pressure of the blast was 12 pounds per square inch, instead of 5 or 6 pounds used on the smaller furnaces. The high pressure seemed to be such a help in getting out large quantities of iron that the coke-furnace owners immediately increased their blast pressures 3 or 4 pounds, with the result that their

outputs were largely increased. With furnaces of the same size the output of a coke furnace at that time was about twice the output of the anthracite-coal furnace, the blast pressure being about four pounds greater for the coal than for the coke. From that time coke has been used exclusively in blast furnaces in Western Pennsylvania and Ohio.

Recently many experiments have been made by the United States Government and by the larger steel com-

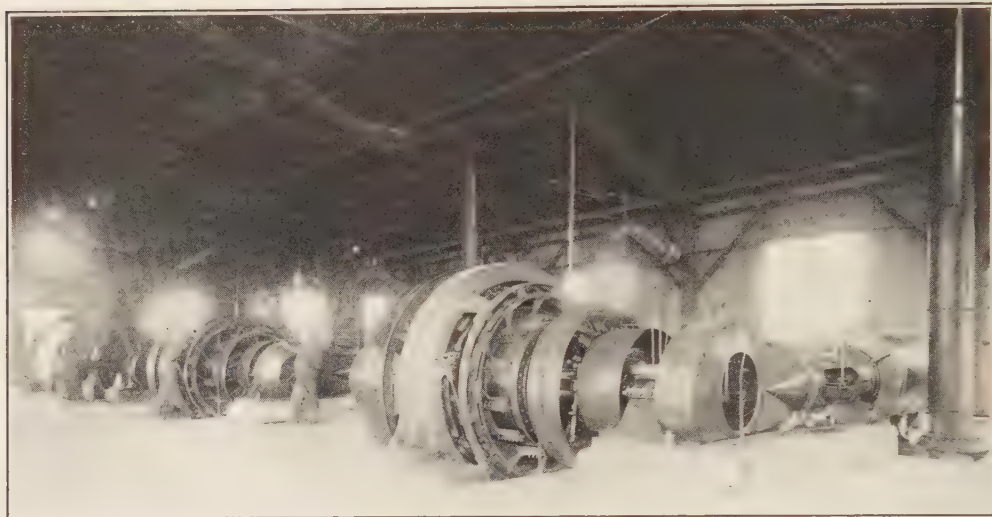


FIG. 20. TYPICAL BLAST-FURNACE POWER-PLANT OF THE OLDER TYPE, USING STEAM ENGINES HOUSED IN A WOODEN BUILDING

panies on making coke from Illinois coals. These experiments have shown that it is practicable to make coke from this coal, and now coke is being made from coal which a few years ago was thought worthless for that purpose.

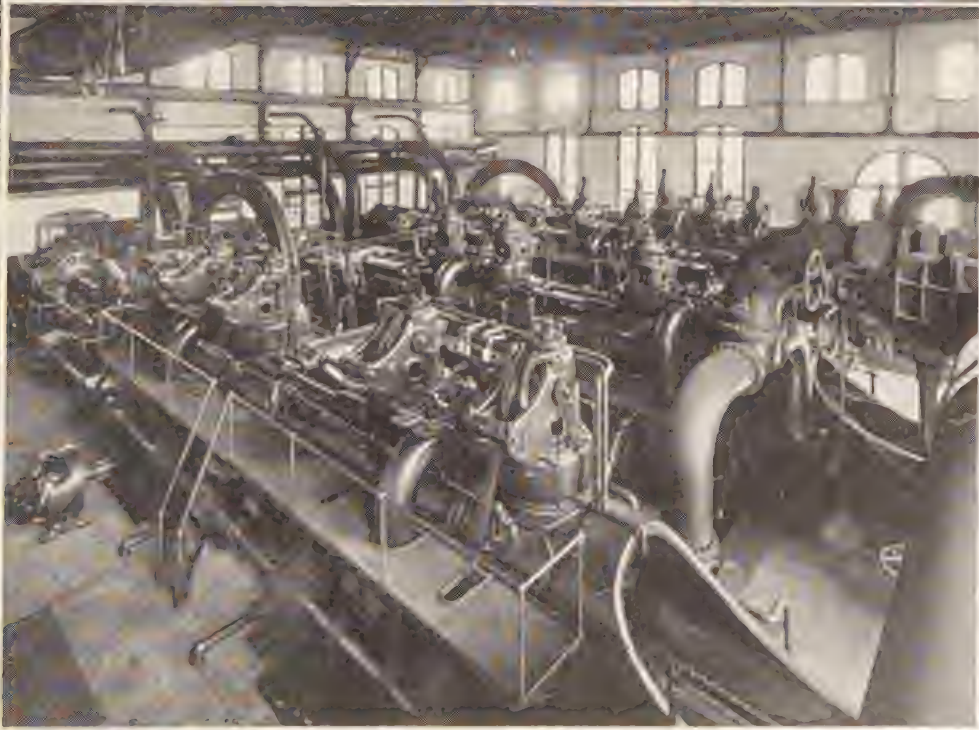
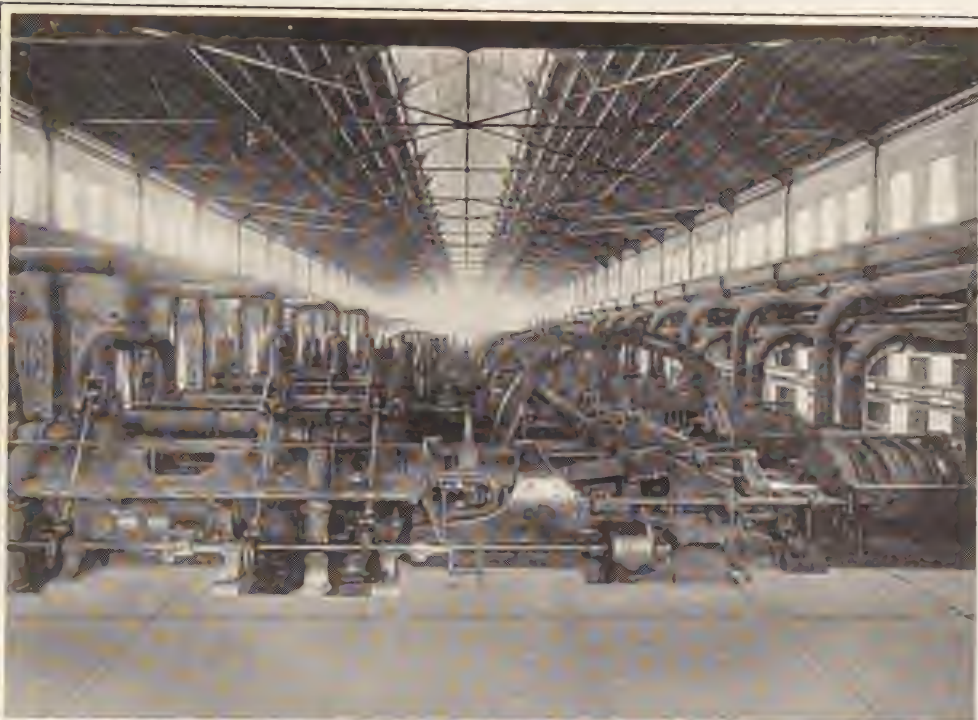
The limit appears to have been reached in the height of the present furnace, about 90 feet, and the diameter, 18 feet 6 inches, has not been increased much since the third and fourth Bethlehem furnaces were built about 1872. Coke is used exclusively for blast furnaces in steel plants, and in the newer plants the coke is made at the furnaces. The furnace charge varies slightly with the composition of the ore, but the average may be taken as follows, the figures being on the basis of one ton of iron produced: Ore, two tons; coke, one ton; limestone, one-half ton. For reducing this "burden" there will be required about 140,000 cubic feet of free air compressed to a pressure of 15 pounds per square inch.

The ton of coke used in making a ton of pig iron will have available about 27,000,000 British thermal units. Of this amount about 5 per

cent is absorbed in the furnace for the evaporation of moisture contained in the charge, 24 per cent for the reduction of the ore, and about 5 per cent for radiation losses—in all, some 34 per cent. In addition, the liquid slag and iron carry out about 14 per cent and 4 per cent respectively, making in all 52 per cent used in the blast furnace proper. The amount of heat supplied to the hot-blast stoves is 28 per cent of the total in the coke, half of which is lost while the other half is recovered through heating the air entering the furnace, thus completing a cycle. Consequently 34 per cent of the heat in the coke is available for power purposes.

The amount of heat in the gas available for power from a blast furnace with a daily capacity of 300 long tons of iron, would be equivalent to 102 tons of good bituminous coal every 24 hours. In isolated furnace plants, where there is no steel plant in connection, this gas is burned under boilers and the steam is used for blast engines, compressing air, pumps and electric generators.

The efficiency of boilers fired with



FIGS. 21, 22. WESTINGHOUSE GAS ENGINES IN BLOWING INSTALLATIONS

Above, eight 2,900 horse-power twin tandem double-acting gas engines, blowing-engine plant of the Indiana Steel Co., 1907. Below, two 2,000 horse-power blowing units, Carnegie Steel Co., 1906

blast-furnace gas is very low. If the steam from the boilers fired by gas from a 300-ton furnace be used in up-to-date steam engines or turbines, only 4,800 brake horse power will be developed, as the combined efficiency will not be greater than 11 per cent. If, however, this gas be used in gas engines with an efficiency of 25 per cent, the power resulting will be almost 11,000 brake horse power. The furnace will require about 3,000 horse power for its own use (air supply, conveying and auxiliary engines, water supply, lighting, etc.), while the balance, 8,000 horse power, will be available for driving rolling mills or other machinery or for outside sale.

Up to the present time the power developed in gas engines from waste gas has been consumed in most cases in the operation of iron and steel works themselves. Since these works often require for their own consumption far less power than the blast furnaces and coke ovens are able to supply, they have a marketable product in the shape of surplus power. In the United States this extra power, in some cases, has been supplied to allied or subsidiary plants, such as cement plants using blast-furnace slag, but in very few cases has any of this power been sold to other consumers. In some other countries the advantages of this enormous power production have been realized to a greater extent.

In the Saar District in Germany a high-voltage system about 50 miles long, belonging to the State collieries, extends in a north-eastern direction from St. Johann Saarbrücken, and carries three-phase current of 10,000 volts. Current is supplied to this network both from a steam-turbine station in Louisenthal of about 15,000 brake horse power and from a gas-engine station in Heinitz which can

develop some 13,000 brake horse power from coke-oven waste gas. The Rhenish Westphalian Electricity Works in Essen has three large steam-power plants allied to three gas-power plants of neighboring iron and steel works and collieries on its cable network, which is about 870 miles long. The capacity of this system is about 38,700 kilowatts.

On the northeast coast of England a long-distance system is operated by the Newcastle-on-Tyne Electric Supply Company, consisting of eight power stations developing about 102,000 horse power. This system supplies power to numerous shipyards and engineering works. Five of the eight stations, developing about 53,000 horse power, operate on waste gas from blast furnaces and coke ovens, which is at present still utilized in steam plants. By installing gas engines the output could be increased by at least 50,000 horse power, while if the total output of the system were maintained, some 100,000 tons of coal yearly which is now used by steam plants could be saved.

The pig-iron production of the United States is at present about 25,000,000 long tons per year. If all the waste gas resulting from the manufacture of this iron were used in gas engines, the result would be 2,000,000 brake horse power available over and above the needs of the furnaces.

BLOWING ENGINES

The old type of walking beam blowing engine has been entirely superseded by the Corliss engine with air or blowing cylinder placed tandem with the steam cylinders. The steam cylinders are usually compounded and the most common size is with a high-pressure cylinder from 40 to 50 inches in diameter, a low-pressure cylinder from 80 to 100

inches in diameter, and a common stroke of from 54 to 66 inches. An

two air cylinders 84 or 86 inches in diameter, run 40 to 50 revolutions per minute, and compress 30,000 to 40,000 cubic feet of free air per minute to a pressure of 16 pounds per square inch.

The valves used on the air cylinders are usually mechanically and positively operated, the old style of simple poppet valve having been discarded entirely. This was made necessary by the increase in piston speeds from 300 to 600 feet per minute which became necessary when gas engines were introduced into the United States for blast-furnace work. The valves, which are usually placed in the cylinder head to cut clearance down to a minimum, are of the piston, poppet, or gridiron type, made as large in area as possible. All these valves give more or less trouble at piston speeds approximating 600 feet per minute, so that something new had to be designed to do the work. One of the most successful of the newer designs is that of Mr. E. E. Slick of Pittsburgh. In order to get an inlet valve of large area, Mr. Slick made the cylinder proper movable, and this serves as a sleeve valve giving an annular opening of great area without increasing the clearance. This valve, which operates well in large sizes at 75 revolutions per minute, is very similar to the Knight sleeve valve which has recently been applied to the operation of automobile motors.

We are indebted to Europe, not only for the gas-driven blowing engine, but also for the turbo-compressor. The progress of this type of compressor for blast-furnace work was checked in Europe owing to the high cost of fuel and the larger consumption of the steam turbine as compared with the gas engine. Recently the turbo-compressor was introduced into the United States and here the lower cost of coal and higher

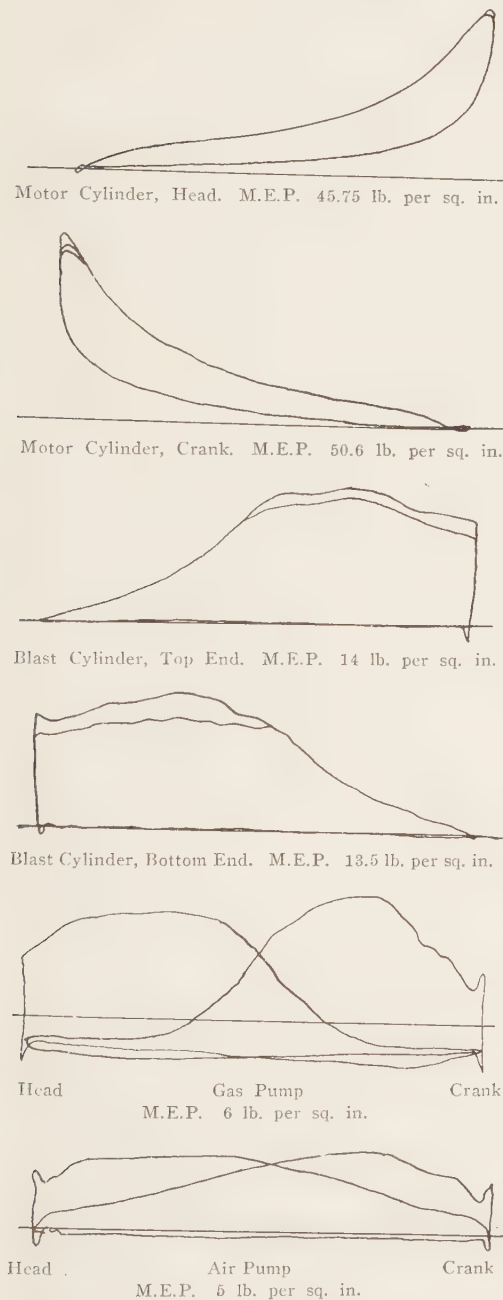


FIG. 23. INDICATOR CARDS FROM KOERTING BLAST-FURNACE GAS BLOWING ENGINE OF 2,000 HORSE POWER

engine with steam cylinders 48 and 84 inches by 60 inches would have

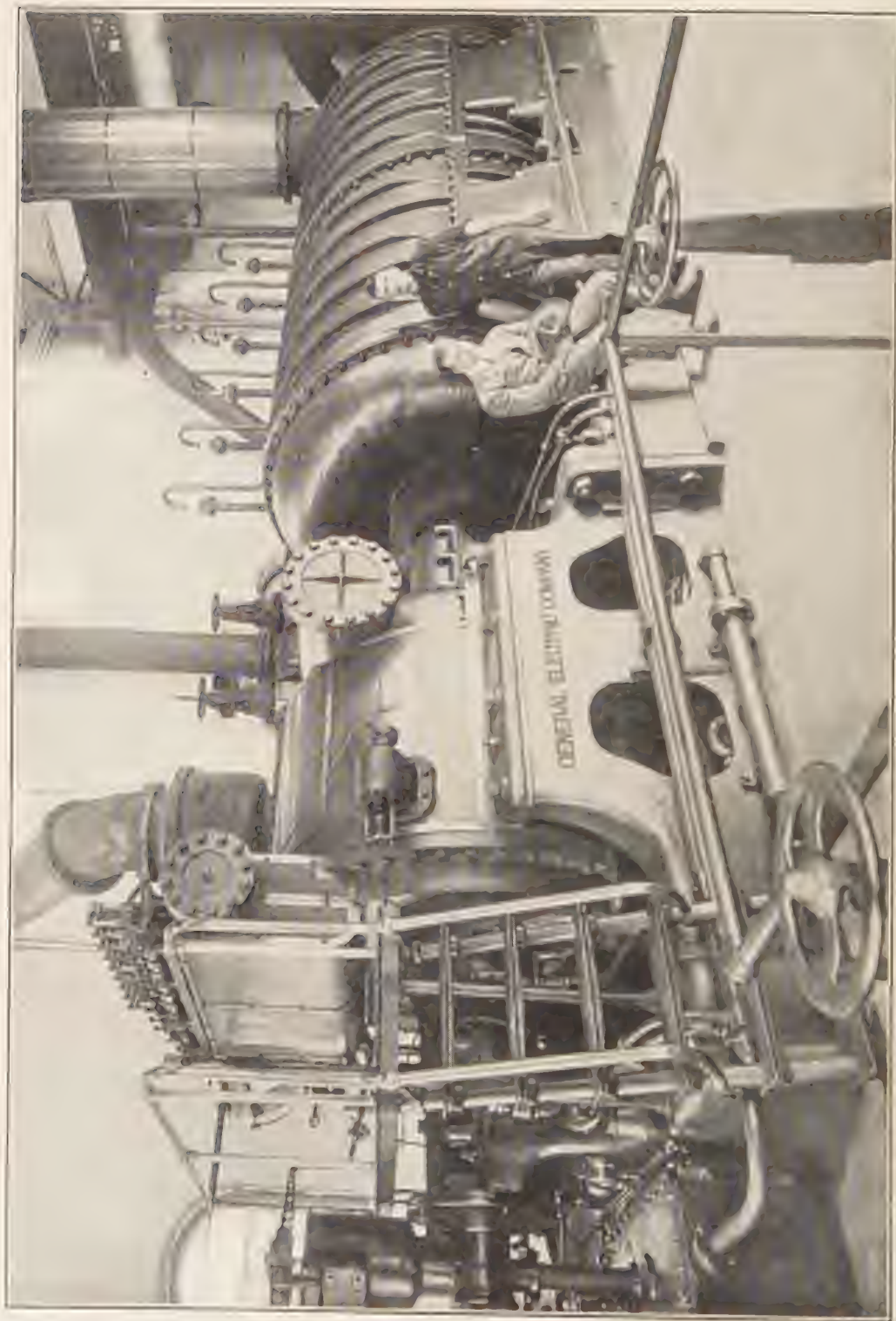


FIG. 42. STEAM TURBINE DIRECT-CONNECTED TO CENTRIFUGAL AIR COMPRESSOR, EMPIRE STEEL CO. WORKS, N. Y.
Credit: Engineering Co.

wages of operating labor will favor the installation in some places.

The first centrifugal compressor unit installed for blast-furnace work in the United States was at the plant of the Empire Iron and Steel Company at Oxford, N. J. The compressor is a six-stage unit direct-connected to a four-stage Curtis turbine and operating at a normal speed of 1,650 revolutions per minute. At this speed the compressor delivers 22,500 cubic feet of free air per minute against a head of 15 pounds per square inch.

turbine is designed to operate with steam at 150-pounds pressure and to exhaust into a vacuum of 28 inches, although overload valves are provided which allow the turbine to give full load when running non-condensing.

The compressor impellers are of the double-inlet type; that is, the air is admitted to both sides of the impellers in order to obviate any axial unbalanced thrust. The impellers are 54 inches in diameter. Surrounding the impellers are stationary discharge vanes mounted within the casing, and

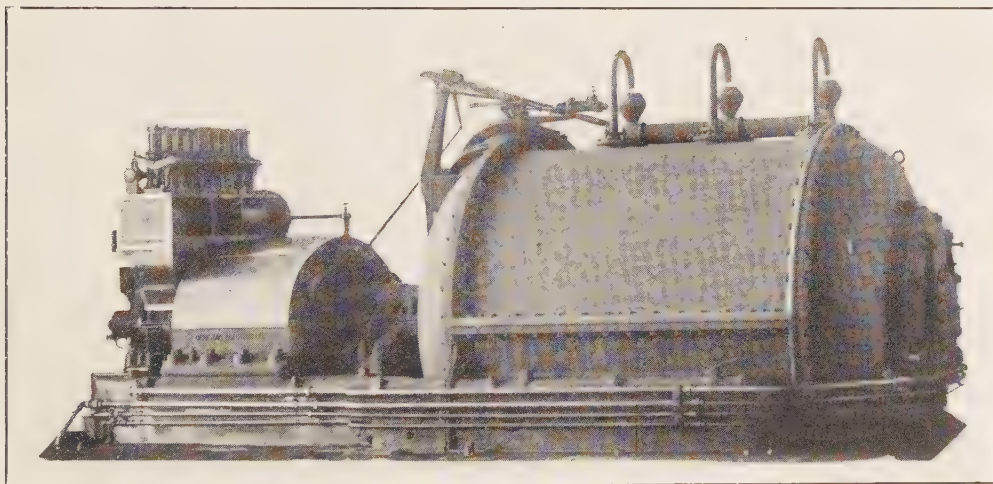


FIG. 25. CURTIS TURBINE, 2,900 HORSE-POWER, DIRECT-CONNECTED TO 3-STAGE CENTRIFUGAL COMPRESSOR

Delivering 40,000 cu. ft. of free air per minute to a pressure of 30 lb., developing 5,400 horse power

A more recent development is a unit with a three-stage compressor direct-connected to a five-stage Curtis turbine. At its normal rating this machine will deliver 35,000 cubic feet of free air per minute against a pressure of 15 pounds per square inch when running at 2,500 revolutions per minute, the power required being 2,700 horse power. This unit is capable of delivering 40,000 cubic feet of free air per minute with a pressure of 30 pounds per square inch, the power required in this case being about 5,400 horse power with a speed of 3,250 revolutions per minute. The

between the successive impellers is a water-cooled diaphragm, so shaped and mounted in the casing that the proper air passages are obtained.

It is interesting to note the small size of the turbo-compressor units compared to the reciprocating-engine units. The floor space occupied by the turbo-compressor unit is 26 feet in length, 16 feet in width, and the height is about 11 feet. The space occupied by the horizontal cross-compound steam-driven blowing engine of the same capacity is about 78 feet in length and 38 feet in width. For the cross-compound vertical steam

unit, the floor space required is about 30 by 40 feet and the height of the unit is 37 feet. The twin tandem gas engine, such as is usually used for blast-furnace blowing purposes, requires a floor space 34 by 91 feet. The gas-driven unit weighs nearly 2,000,000 pounds and the turbo-compressor 150,000 pounds.

BLAST FURNACE HOISTS

The use of automatic hoists for blast-furnace work dates back to 1872. At that time and up to 1895, vertical lifts consisting generally of

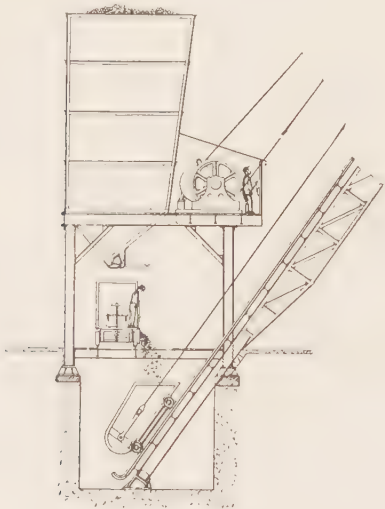


FIG. 26. ARRANGEMENT OF BINS AND HOPPERS FOR LOADING BLAST-FURNACE SKIPS
Otis Elevator Co.

a duplex-cylinder vertical design of single-drum steam winding engine, with automatically controlled brake and terminal stop valve, were used in connection with a pair of cages of iron and hard wood equipped with safety catches, and were almost invariably adopted for hand-filled blast furnaces as then operated, having an output of from 50 to 150 tons of pig iron a day.

The first skip furnace-hoist was constructed in 1895 for the Punxsutawney Iron Company, Mr. Julian Kennedy, engineer, and was a double-car arrangement of his design. The

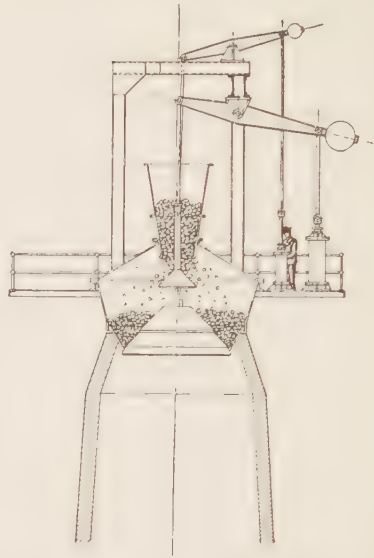


FIG. 27. SMALL BELL ON BLAST-FURNACE TOP DISCHARGING SKIP LOAD INTO THE CLOSED LARGE BELL
Otis Elevator Co.

engine in this case was fitted with two winding drums with a spreader between, placing the drum centers apart the same distance as the overhead sheaves.

The type of automatic control first introduced for skip-hoist service was

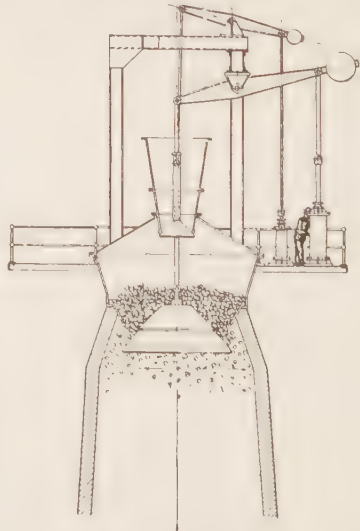


FIG. 28. LARGE BELL DISCHARGING "ROUND" INTO FURNACE
Otis Elevator Co.

cutting off the steam more or less as required to land the different weights of ore, coke and limestone at a given point. The automatic device on this first and several subsequent similar incline hoists was dependent on the control of the steam inlet. It was barely possible to fill the furnace successfully with such an automatic arrangement, and only when there was but little difference in weight of the skip loads and but little variation of

on furnaces as large as 600 to 700 tons of iron output per day.

The steel plant of today with its central power-station composed of gas engines driving electric generators demands an electrically driven furnace hoist. The hoist driven by the steam engine was not economical and was rendered still more expensive in operation by the great loss in condensation due to long steam lines.

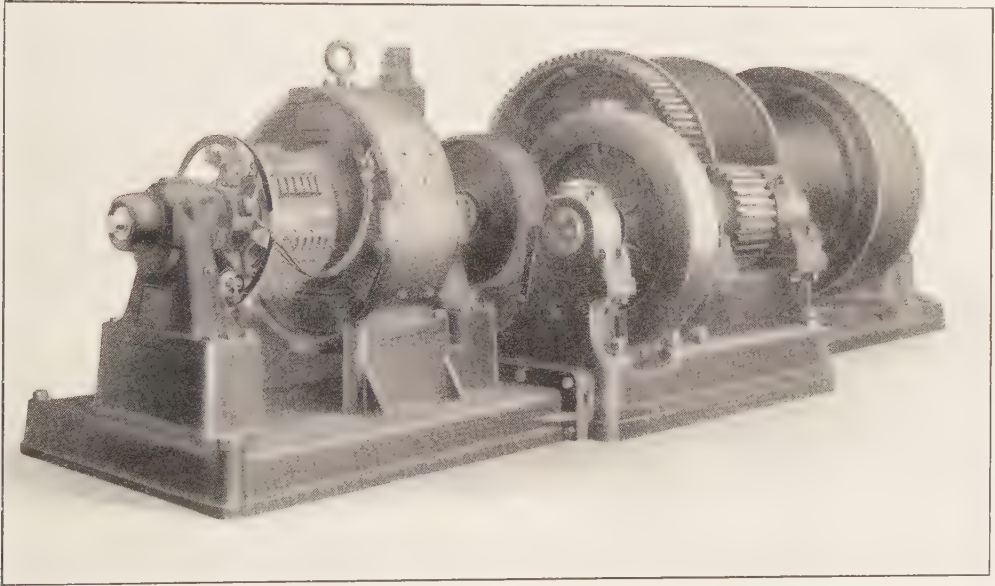


FIG. 29. OTIS DIRECT-CURRENT AUTOMATIC SKIP HOIST

the steam pressure, and when double skip cars that balanced each other were used; but it was proven by these first installations of inclined self-dumping hoists, that men on the tops of furnaces could be dispensed with entirely, and in addition to saving that expense and doing away with the risk to life, much larger furnaces could be operated. The matter of automatic control with steam-engine hoists was much improved by the combined inlet and exhaust control which was first used by the Otis Elevator Company on their hoists. With this control engines will work well on either single or double skips, and

One of the various methods of loading the furnace skip with the charge is illustrated in Figure 26. In this system the ore, coke, and limestone are stored in large bins located near the furnace. Under these bins and running on tracks is a charging truck which is also a weighing machine. The material falls by gravity into the truck and is transferred by it to the elevator skips which are generally arranged in pairs, one ascending loaded while the other is descending, empty, so that when one at the bottom is being loaded the other is discharging its load into the small bell-shaped hopper at the top of the

furnace. The small bell discharges each skip load into the larger bell, the latter remaining closed until it receives a round, when it discharges its load into the furnace—the small one remaining closed during this operation. These bells may be operated by hydraulic cylinders, compressed air, or electric motors. In the newest furnace at the Lackawanna Steel Company at Buffalo, the bells are operated by oil under 500-pounds pressure. The bells of the other Lacka-

and limestone, but the following is adopted at some furnaces:

First round—18,000 pounds ore, then 4,000 pounds coke, and again 4,000 pounds coke.

Second round—18,000 pounds ore, then 8,000 pounds limestone, then 4,000 pounds coke, and again 4,000 pounds coke.

The coke being much lighter than the ore, the skip will carry only 4,000 pounds of the former to 18,000 of the latter.

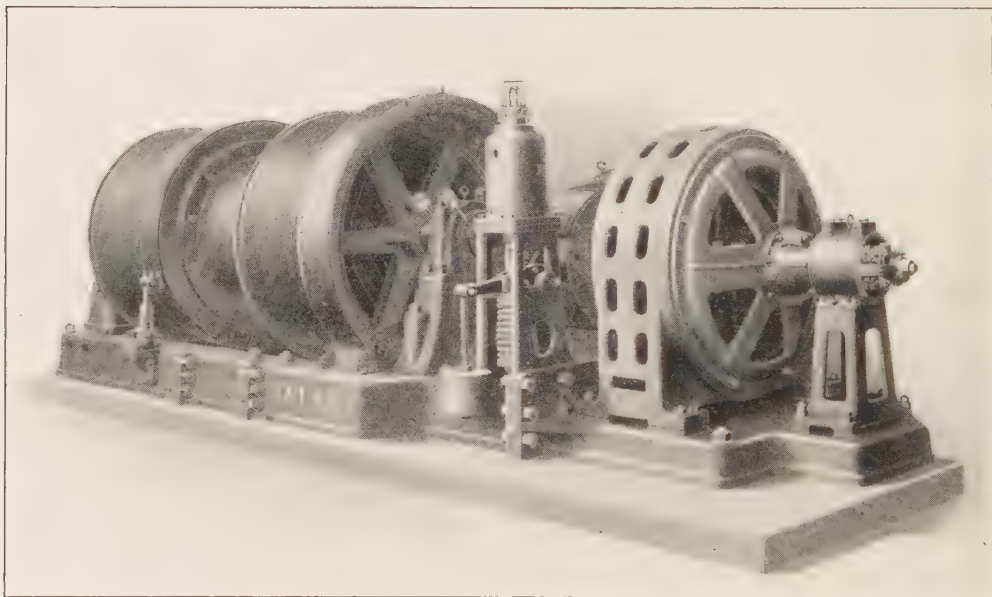


FIG. 30. OTIS ALTERNATING-CURRENT AUTOMATIC SKIP HOIST

wanna furnaces are operated by air at about 80-pounds pressure, and at the Gary, Indiana, furnaces the bells are operated by the blast air at 15-pounds pressure. In the electric control installed by the Otis Elevator Company, the crank pin of the electric bell hoist is connected to the bell lever, one revolution of the crank shaft causing the bells to open and close. The operator starts the machine and it is brought to rest automatically after the crank shaft has made one revolution.

The full round charge varies in quantity and proportion of coke, ore

The total height of the modern furnace is from 80 to 100 feet. The incline is about 30 degrees from the vertical, and the speed of the hoist varies from 200 to 500 feet per minute, a trip generally consuming from 20 to 60 seconds.

The modern electric blast furnace hoist is a good example of one of the highest types of electric motors and at the same time is an illustration of maximum work accomplished with minimum manual labor or attendance. The action of the hoist is so interesting that a detailed description will be given.

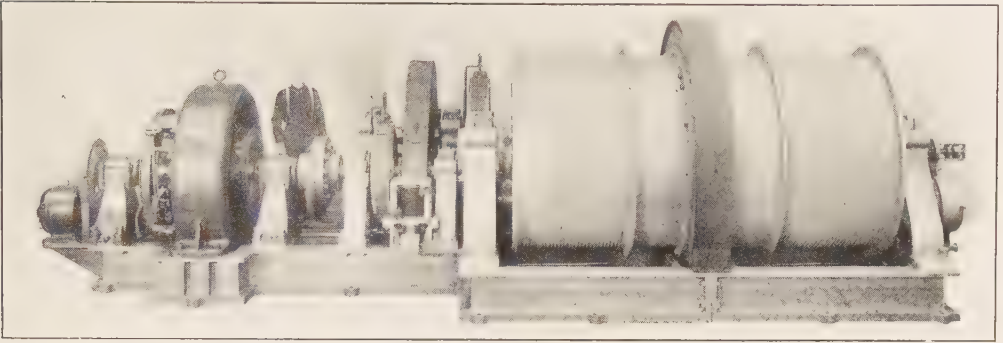


FIG. 31. LIDGERWOOD HOIST, TENNESSEE COAL & IRON CO.

Hoists 15,000 lb. at 250 ft. per minute. Operated by Crocker-Wheeler direct-current motor of 130 horse power

In Figure 27 is shown an Otis direct-current hoist. The drums are 72 inches in diameter and of 40 inches face, these drums being coupled together by a distance piece to suit the distance between centers of the tracks. The gears are of steel for unbalanced loads from 8,000 to 20,000 pounds, but below 8,000 pounds the gears are made of cast iron. The brake drum is mounted on the armature shaft.

The motor is heavily compounded, making about 400 revolutions per minute, the horse power being from 150 to 300. The brake is of the steel-band type, leather-lined, and relieved

by a solenoid magnet; the brake power is produced by a combination of heavy springs and weights. The controller is of the magnet control type, gradually cutting out the starting resistance and series field by the accelerating magnet, its spool being connected to the armature terminals, causing the contacts to close as the speed and counter electromotive-force of the armature increases. This method limits the starting current to a predetermined amount.

The automatic stopping for dumping into the bell is accomplished by a series of magnets, their circuits being controlled by the automatic stop mo-

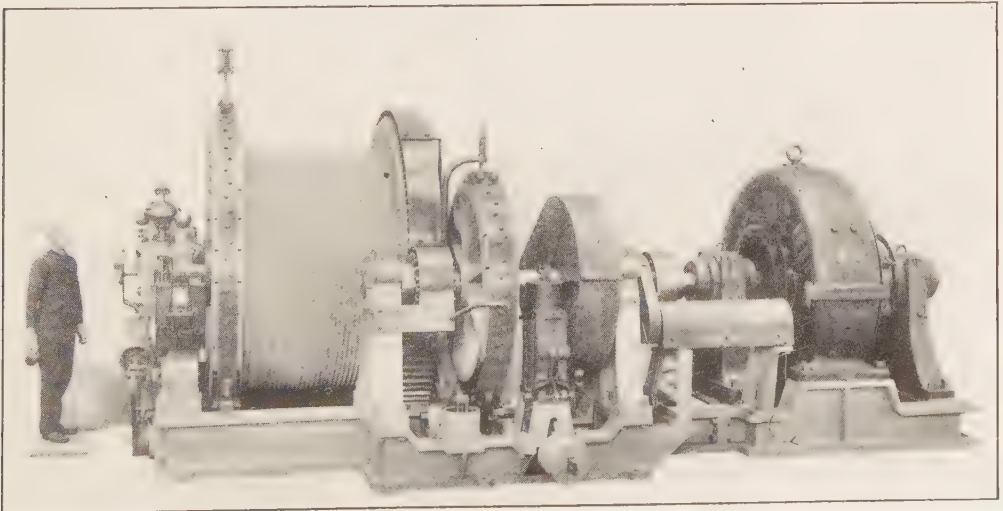
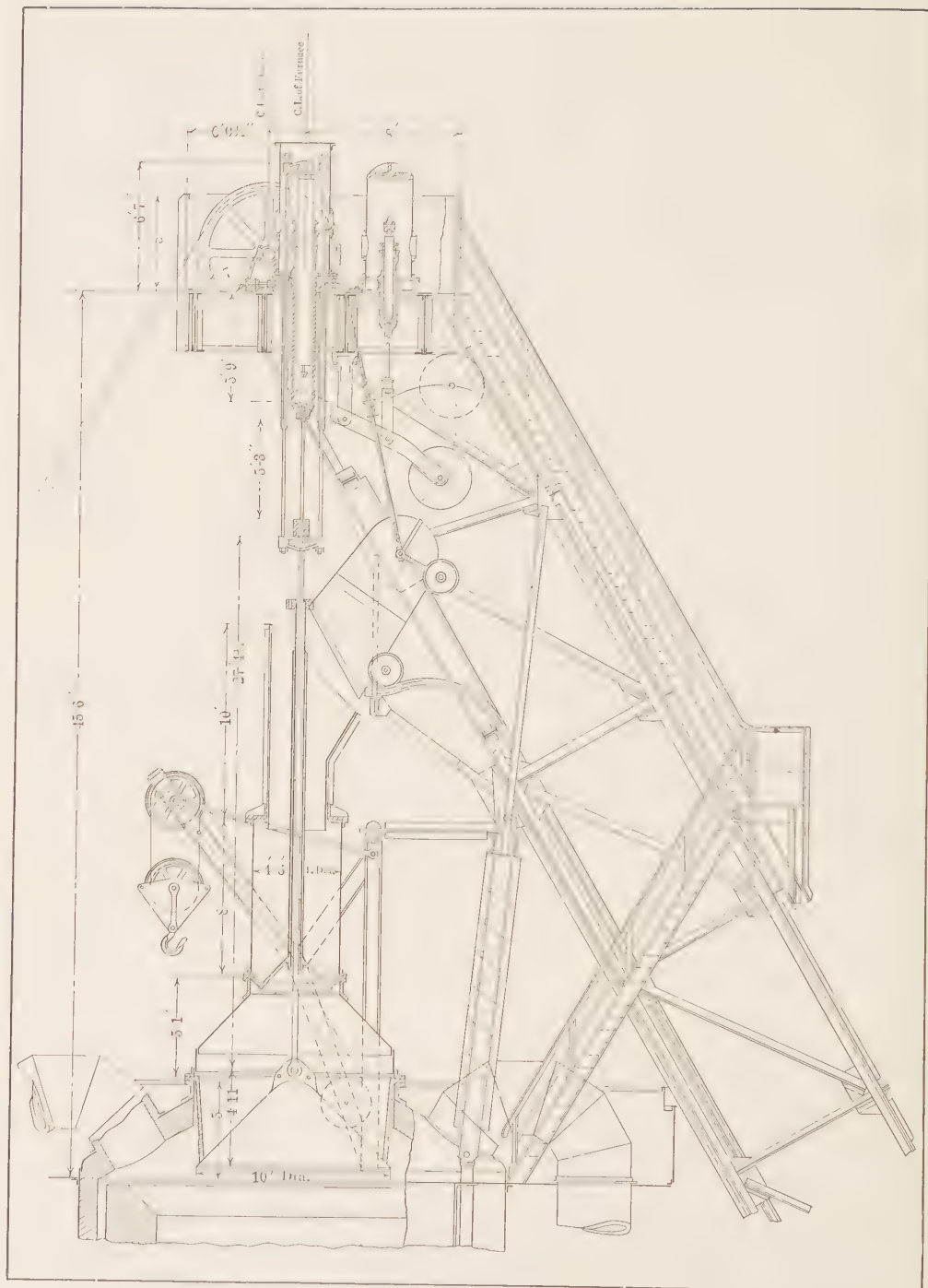


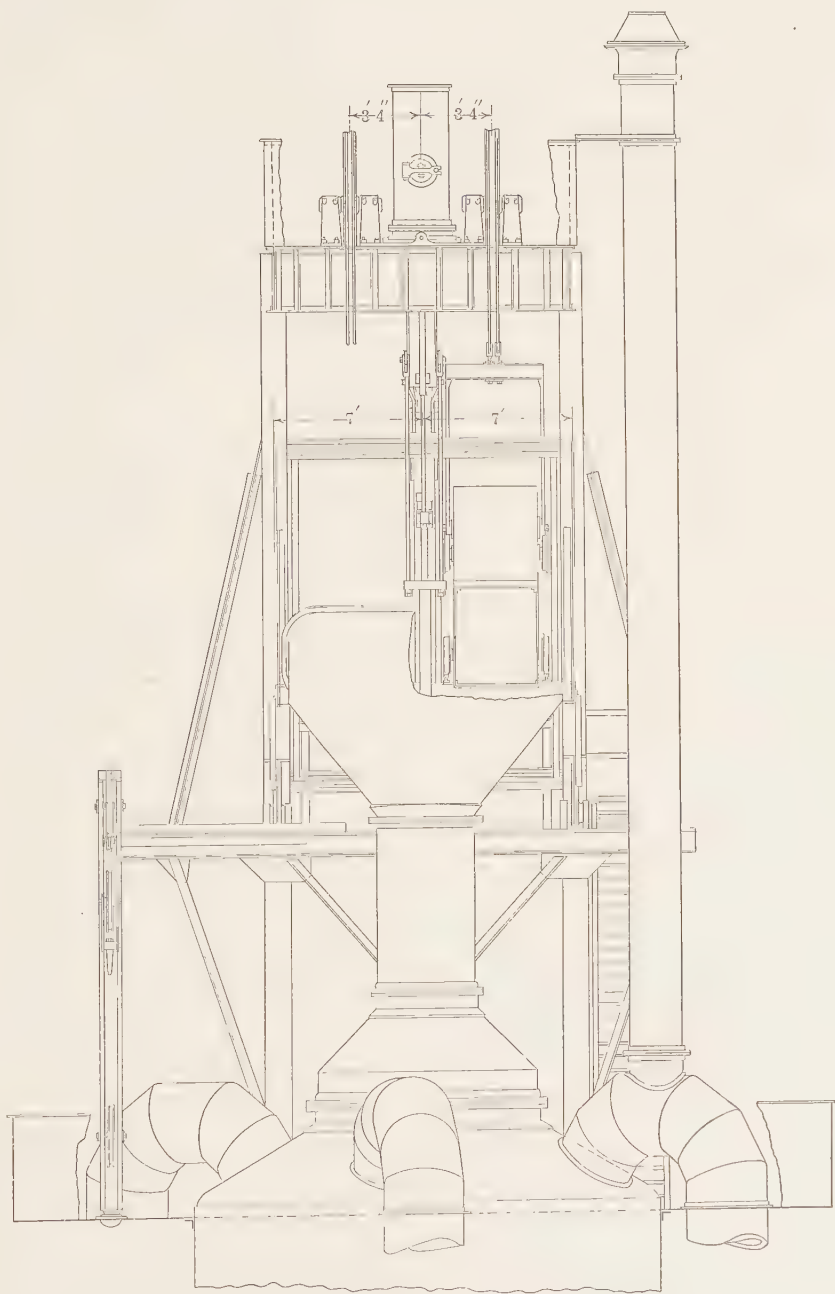
FIG. 32. LIDGERWOOD HOIST, CARNEGIE STEEL CO.

Capacity 13,000 lb. at 570 ft. per minute, using a Westinghouse 300 horse-power motor for 220 volt direct-current



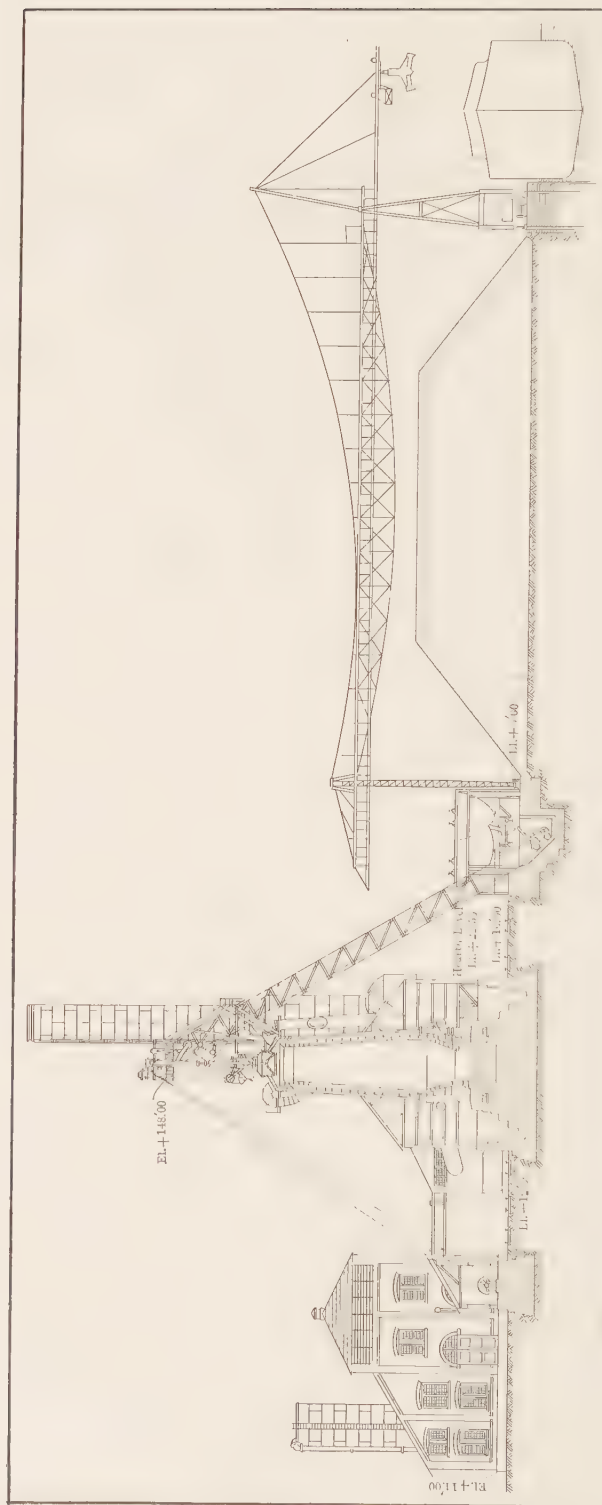
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FIG. 33. GENERAL ARRANGEMENT OF BLAST-FURNACE TOP
Mr. Julian Kennedy, Engineer



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FIG. 34. GENERAL ARRANGEMENT OF BLAST-FURNACE TOP
Mr. Julian Kennedy, Engineer



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FIG. 35. SECTIONAL ELEVATION OF BLAST-FURNACE PLANT
Mr. Julian Kennedy, Engineer

tion switch. The first function of the automatic switch is to make the motor change speed in proportion to the load.

As soon as this has been established the automatic stop motion switch makes the circuit of the load magnet, so that its contacts are made proportional to the potential of the armature, which corresponds to the speed. A slow-down effect is therefore automatically regulated in proportion to the load in the bucket and causes the hoist to stop at the same point independent of the load. The operator is only expected to throw his switch over for either up or down. This operating switch can be placed in any convenient position. An emergency brake is sometimes provided. This brake is tripped by a speed governor and brings the hoist to rest if for any reason excessive speed is attained.

The first electric hoists made by the Otis Elevator Company were two for the Rombacher Steel & Iron Company in Germany and two for the Ohio Steel Company, U. S. A. Some of the largest equipments installed since then have been:

National Steel Company.....	6
Carnegie Steel Company.....	10
Jones & Laughlin.....	7
Colorado Iron & Fuel Company..	4
Lackawanna Steel Company.....	7
Indiana Steel Company.....	8
National Tube Company.....	5
In Great Britain—	
Bolckow, Vaughn & Co.....	3
Dowlais, Wales	2

The last mentioned installation is interesting because Dowlais, Wales, is one of the oldest centers of the iron and steel industry and shows how the oldest institutions must take on new life to compete with newer organizations. In this particular case the machine was one of the largest, the duty called for being 13,400 pounds to be hoisted at 500 feet per minute.

The Lidgerwood hoist shown in Figure 31 was built for the Tennessee Coal and Iron Company. Its duty is 15,000 pounds at 250 feet per minute, operated by a Crocker-Wheeler motor of 130 horse power. This hoist has an automatic control with an auxiliary generator to supply current for the same. The weight of this hoist complete is 71,000 pounds, massive construction being necessary in every detail in order to meet the demands for an absolutely reliable machine under all conditions and for continued service.

In Figure 32 is shown a direct current hoist built for the Carnegie Steel Company by the Lidgerwood Manufacturing Company of New York. The capacity of this hoist, 13,000 pounds, is not as great as that of many other hoists, but the speed is high, being 570 feet per minute. This high speed requires a motor of large power, in this case a Westinghouse motor of 300 horse power. The rope is $1\frac{1}{4}$ inches in diameter.

Slowing down is accomplished through an automatic limit switch mounted on a heavy cast iron bed-plate and driven from the armature shaft. The device is so constructed that the speed of the bucket at slow down is exactly the same in every case regardless of the load. A test of twenty-five trips with varying loads showed that the bucket stopped within five-eighths of an inch of the same spot every time.

The hoisting machinery requirements for blast furnaces are probably more severe than for any other class of hoisting machinery, as these machines are called upon in many cases to keep up their cycle of operations day and night without interruption or stopping for repairs from the time the furnace is blown in until it requires relining, often covering a period of two years.

PRODUCTION OF GASOLINE FROM NATURAL GAS

By C. F. Hirshfeld

Rapid and constantly accelerating growth in the introduction and use of small internal-combustion motors has reversed, within a few years, the economic position of gasoline as a commodity. Any development which might possibly reduce the resulting industrial difficulty is interesting, and to this interest Professor Hirshfeld adds that of a suggestive mechanical discussion.—THE EDITORS.

THE constantly increasing demand for gasoline and the difficulty experienced in meeting this demand with the product of the oil refineries lend great interest to any other possible method of producing this commodity. Such an alternative method has acquired considerable prominence during the past few years.

The process referred to results in the production of gasoline from what is called natural gas. By natural gas is meant any combustible gaseous material arising from wells in oil and gas regions. Such gas ranges from "dry" gas, which consists largely of methane, CH_4 , and has a specific gravity in the neighborhood of 0.6, to the very heavy vaporous "head casing gas" rising from oil wells. The latter gas often has specific gravity greater than unity as compared with air and contains appreciable quantities of the first seven or eight members of the paraffin series of hydrocarbons, i.e., methane, ethane, propane, butane, etc.

Little, if any, gasoline can be recovered from dry gas; comparatively large quantities can be obtained from the heavier varieties.

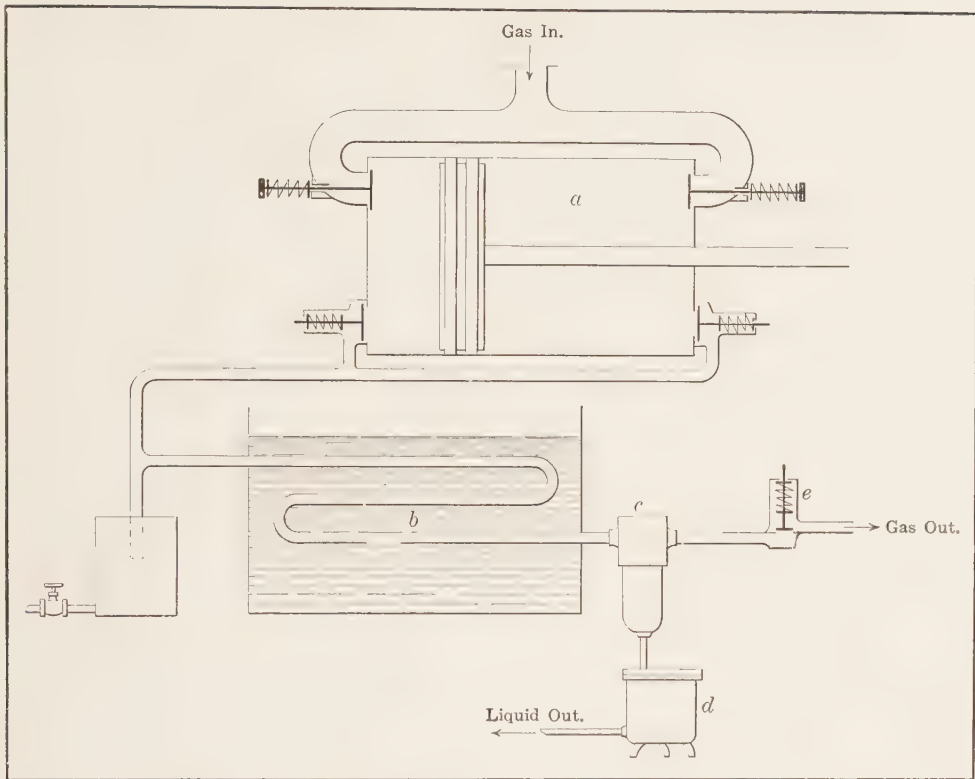
The plant required for the recovery of gasoline from gases of this kind is very simple and comparatively inexpensive. It will be shown later that several distinctly different methods might be used, each involv-

ing characteristic apparatus. At present, however, there is practically only one method and type of plant in use. This is shown diagrammatically in Figure 1.

In this figure *a* is a compressor, *b* a cooler or condenser, *c* a separator, *d* a trap, and *e* a pressure-regulating or relief valve. In operation, gas is compressed in *a*, cooled at practically constant pressure as it passes through *b*, and the liquid gasoline which results is separated at *c*, from which it drains into the trap *d*. The trap discharges the gasoline into a convenient storage vessel or tank. The gas from which the gasoline has been removed passes through the relief valve to a distributing pipe system or to waste.

It will be observed that this apparatus is merely a simple modification of that used when natural gas is to be prepared for pipe-line transmission. Indeed the process is merely an outgrowth of such preparation. It was often observed that a liquid drained out of natural-gas lines, particularly when the pressure was high and the temperature happened to be low. When investigation showed this liquid to be a high-grade gasoline, little further incentive was required to bring about the perfection and commercialization of the process just described.

Experience has shown that as many as eight to nine gallons of high-



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FIG. 1. DIAGRAMMATIC REPRESENTATION OF COMPRESSOR

grade gasoline can be obtained per thousand cubic feet of heavy gas with specific gravity in the neighborhood of 1.1 referred to air. In general, the possible gasoline recovery decreases as the specific gravity of the gas decreases, becoming practically zero with a specific gravity in the neighborhood of 0.6.

The gasoline made in this way should properly be regarded as a by-product of the gas business and should be manufactured by each producer only to the extent made possible by the sale and utilization of gas. It is however almost unnecessary to state that this is not the actual condition of affairs; owners and operators of gas-producing properties have in many instances continued the manufacture of gasoline in such quantities that they have been compelled to waste large volumes of gas for which

there happened to be no market. Such waste of our natural resources has been too well aired of late to require further comment.

In the early days of the recovery of gasoline from natural gas the process was shrouded in mystery. Even at the present time many of the users of the process have no very clear idea of the principles involved; operation is controlled largely by a cut-and-try method and nearly all data are empirical. The phenomena involved can be simply explained in a more or less general way and considerable of the air of mystery be thus dispelled.

We shall assume for this purpose that the process is entirely a physical one, that is, that it involves no chemical changes. The absolute correctness of this assumption has not yet been proved, but it seems almost certain that no chemical changes of any

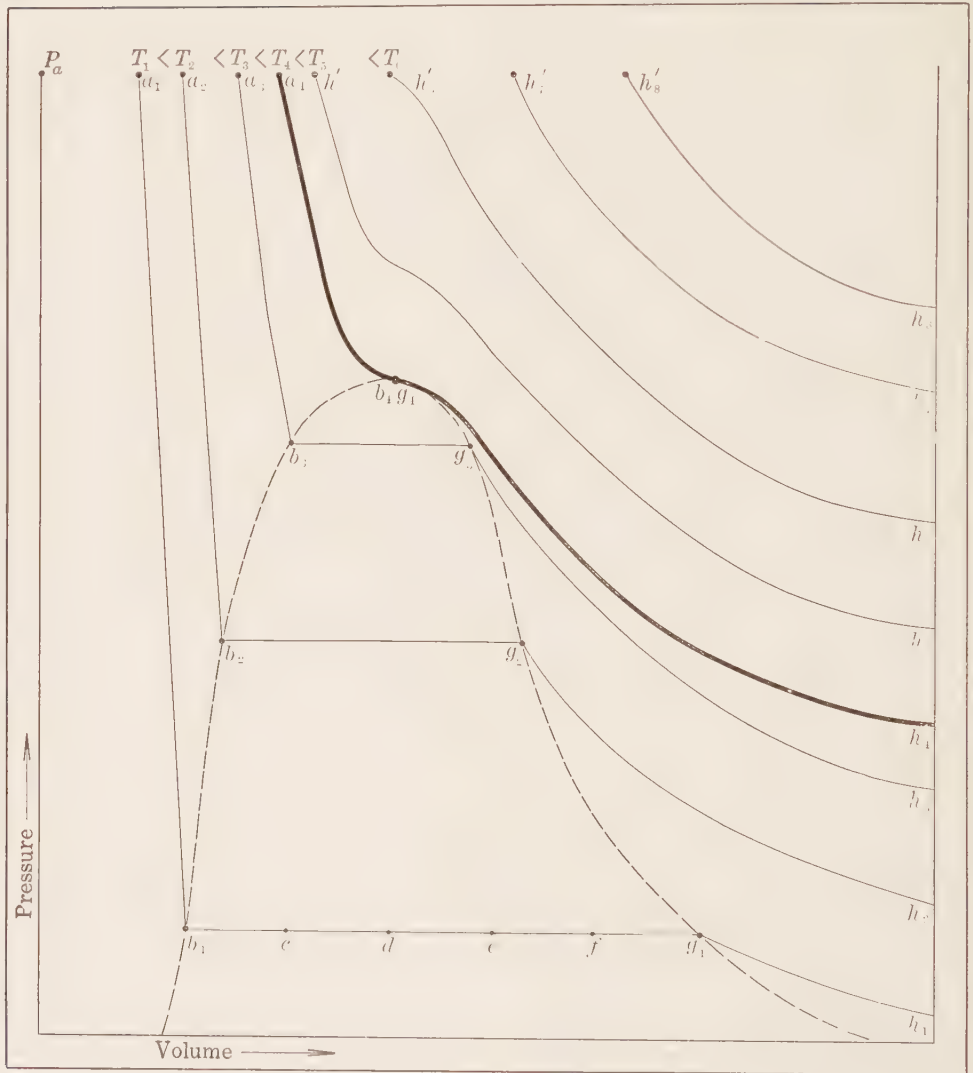


FIG. 2. PHYSICAL EQUILIBRIUM DIAGRAM

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magnitude occur. According to this assumption we must assume that the natural gas as produced from the well contains in gaseous form the hydrocarbons which will later be obtained as liquid gasoline. These hydrocarbons may be pictured as existing in the natural-gas mixture in much the same way as water vapor, humidity, exists in the mixture which we call air. It will help in following the discussion if this viewpoint is constantly kept in mind.

It is well known that commercial gasoline is not a definite chemical compound, but merely a mixture of such compounds. The better grades of gasoline are mixtures of very closely related hydrocarbons of the kind previously mentioned as occurring in heavy gas. They have very nearly the same boiling points and all other properties are closely related. If the average boiling point is about right, if the average density is about right, and if upper and lower

limits are not too widely separated the mixture can be marketed as gasoline.

Our problem is to determine the physical condition of such gasoline-forming compounds when in the gas, and the methods by which they can be changed from gaseous form to a liquid which can be handled and transported, as such, at ordinary temperatures and pressures. The problem is best approached by means of diagrams such as those shown in Figures 2, 3 and 4, which may be called liquid, vapor, and gas diagrams, or simply physical equilibrium diagrams.

These diagrams are plotted to pressure and volume co-ordinates, pressures being plotted vertically and volumes horizontally. It is convenient to plot in terms of specific volumes, that is volumes per pound of material. Any point in the diagram represents the volume occupied by a pound of material at some definite pressure and, as we shall learn shortly, at some definite temperature.

To construct such a diagram, assume that the point a_1 in Figure 2 represents the volume of one pound of some liquid under a high pressure P^a and at a temperature T_1 .

If the pressure upon the liquid is decreased while the temperature is maintained constant, the volume of the liquid will, in general, increase slightly as shown by the inclination of the line $a_1 b_1$. Such a process could be continued until at some point, b_1 , the pressure attained corresponded to that of the saturated vapor of the material in question at the temperature T_1 .

The condition of the material at this point would correspond exactly to that of water at steam temperature in a steam boiler. Any attempt to lower the pressure upon such water would result only in the vapor-

ization of some or all of it at constant pressure if provision were made to maintain a constant temperature. To maintain this constant temperature it would only be necessary to supply the requisite heat of vaporization. This will be recognized as just what takes place continuously when a boiler is supplying steam.

Returning now to the material the condition of which was supposed to be represented by the point b_1 in Figure 2, if the volume is allowed to increase while the temperature is maintained constant as before, the liquid will vaporize at constant pressure. The mixture of liquid and vapor will occupy successively larger and larger volumes as represented by the points c , d , e , etc., until, when the last particle of liquid disappears, the volume occupied will be the specific volume of the dry saturated vapor of the material in question when at temperature T_1 . This volume is represented by the abscissa of the point g_1 in the figure.

A further reduction in pressure with the maintenance of the same constant temperature will result in the formation of unsaturated or superheated vapor. The material in this state will behave somewhat like an ideal gas, the relation between pressures and corresponding volumes being such as to give the curve $g_1 h_1$, resembling the rectangular hyperbola representing a similar change for an ideal gas.

The broken line $a_1 b_1 g_1 h_1$ may now be seen to represent an isothermal expansion of the material in question from the liquid condition at a_1 to a superheated vapor at h_1 . It may be called the T_1 isothermal.

If we start again with one pound of the same liquid at the same pressure P^a , but at a higher temperature T_2 , it will in general occupy a greater

volume as shown at a_2 . Expanding isothermally as before but at temperature T_2 will give the broken line $a_2b_2g_2h_2$ similar to $a_1b_1g_1h_1$ but higher in the field. This is to be expected, as it is common experience that the pressure exerted by the saturated vapor of a material is higher the higher the temperature.

Similar isothermals are shown for still higher temperatures in the same diagram and it will be observed that all have the same characteristic shape until the T_c isothermal is reached. This exhibits no constant pressure volume increase, which indicated vaporization on the preceding isothermals; that is, points b_c and g_c coincide. Isothermals at still higher temperatures resemble those below less and less as the temperature rises and approach in shape more and more closely the rectangular hyperbola which is characteristic of the ideal gas.

If all the points b_1, b_2, b_3 , etc., and all the points g_1, g_2, g_3 , etc., be joined as in Figure 2, it becomes evident that they lie on two curves which converge at the common point b_cg_c . Remembering that vaporization occurs whenever any of the isothermals cross to the right of the curve $b_1b_2b_3$ and that the increase of volume during vaporization is represented by the lengths of the lines b_1g_1, b_2g_2 , etc., it is obvious that the T_c isothermal, which is tangent at b_cg_c , represents some sort of limiting condition. This condition can be best realized by tracing the lines $abgh$ in the reverse direction.

Starting then at h_1, h_2 etc., the material is a superheated vapor. When any of the points g_1, g_2 , etc., are reached, liquefaction, i.e., condensation, begins and it is complete when points b_1, b_2 , etc., are reached. Starting with h_c it is found that there is no horizontal line g_cb_c but that these two points have become coincident.

The T_c isothermal therefore represents temperature conditions above which no liquefaction can occur and below which liquefaction must occur. In this sense it is a limiting isothermal.

The temperature T_c is called the critical temperature and the pressure and volume at b_c are called critical pressure and critical volume.

For our present purpose it is convenient to divide the equilibrium diagram into several areas or fields as indicated in Figure 3. That part lying below the critical isothermal from a_c to b_c and to the left of the curve $b_1b_2b_3$ evidently represents a field in which the material for which the diagram is plotted must be all liquid. That is, any point in this field represents the volume of one pound of the liquid at some definite temperature and pressure.

The space below the critical temperature isothermal and to the right of the curve b_1g_1 is similarly the field of unsaturated or superheated vapor. This is easily realized by remembering that decrease of temperature from any point in this field will first bring the material to the condition of dry saturated vapor and then will cause liquefaction if continued further.

The space within the curve $b_1b_2b_3g_1g_2g_3$ represents a field of mixed liquid and saturated vapor, varying from all liquid at the boundary b to all saturated vapor at the boundary g .

The remaining area, that above the isothermal T_c , represents what may be called the gas field. This will be brought out more clearly in subsequent paragraphs.

The great use of this diagram from an engineering viewpoint comes from the fact that it enables us to visualize the results of real or assumed processes which result in pressure, volume and temperature changes. For



FIG. 3. PHYSICAL EQUILIBRIUM DIAGRAM

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instance, if we start with material in the liquid state, as at point o in Figure 3, and increase the volume at constant pressure, it is evident that we must also raise the temperature of the material because the line oo' cuts isothermals of successively higher temperatures as it is drawn to the right. The material in question will eventually vaporize, as shown by the fact that the line oo' enters the mixed field, and after complete vaporization it will become superheated. This whole process will be recognized as

that which takes place in a superheating steam boiler which is supplied with feed water at a temperature below that corresponding to the pressure carried.

Any other line traced through the various fields to represent an assumed process would indicate in a similar way just what physical states the material must pass through. It is obvious that starting with any point in the gas field it is impossible to bring about liquefaction by any process which does not involve cross-

ing of the critical isothermal. From this fact the common definition of the critical temperature follows, i. e., the critical temperature of a gas is the temperature above which it cannot be liquefied by any increase of pressure or decrease of volume. It should be noted that the higher its critical temperature the more easily can a material be liquefied under ordinary conditions, while those materials which have very low critical temperatures are difficultly liquefiable and are known as permanent gases.

With the aid of such diagrams as these the manufacture of gasoline from natural gas is easily visualized and the reasons for the various steps can be appreciated. Those constituents of the gas which will later be condensed to form gasoline exist in the gas as superheated or saturated vapors mixed with other superheated vapors of lower critical temperatures and with gases which have still lower critical temperatures. Just what may be the chemical constitution of the gasoline-forming vapors is really immaterial for our present treatment. For the double purpose of simplifying the problem and of having a definite material to think of we shall, however, assume that there is but one such constituent in the gas and we shall call it vapor X. It would in a real case have a chemical formula of the type form C_xH_y and would be mixed with other vapors with similar formulas.

If now a certain quantity of the natural gas is assumed as existing at atmospheric temperature and pressure it contains a certain weight of vapor X which exerts a partial pressure less than atmospheric. This must be true because the sum of the partial pressures exerted by each of the constituents must equal that exerted by the mixture, namely, atmospheric. As the vapor X is below its

critical temperature and as none of it is liquid it must be either a dry saturated or a superheated vapor. In a real case it will, in general, exist as a superheated vapor and the conditions of one pound of it may be represented by a point such as p in Figure 4. This figure is a reproduction of part of Figure 3 with changed pressure scale.

The point p indicates that one pound of the vapor when mixed with the rest of the gas fills a volume V^t , exerts a low pressure P^t and has a temperature t which may be assumed at about 60 degrees F. Its temperature must at any rate be the same as that of the gas of which it forms a part.

The vapor could be liquefied by keeping the pressure of the mixture, and therefore of each constituent, constant and decreasing the volume as indicated by the line pp_1 . This process would, however, in general necessitate cooling to a temperature much lower than the assumed initial value of 60 degrees F. as shown by the fact that the line pp_1 cuts isothermals of lower and lower temperatures in the vapor and liquid fields. As it will, in general, be most convenient to do any necessary cooling by means of surface or well water, liquefaction according to the line pp_1 may be commercially impossible.

This difficulty can be overcome in several ways. If the gas as obtained from the well has a temperature slightly above that of the available water it can be compressed isothermally so that the vapor X behaves as shown by the line h,g_1 in Figure 4. If the relation between gas and water temperatures happens to be about right this process may be continued until the pressure reached by the vapor X is such that cooling with the available water will cause the decrease of volume at constant pressure shown by the line qq_1 . This obviously

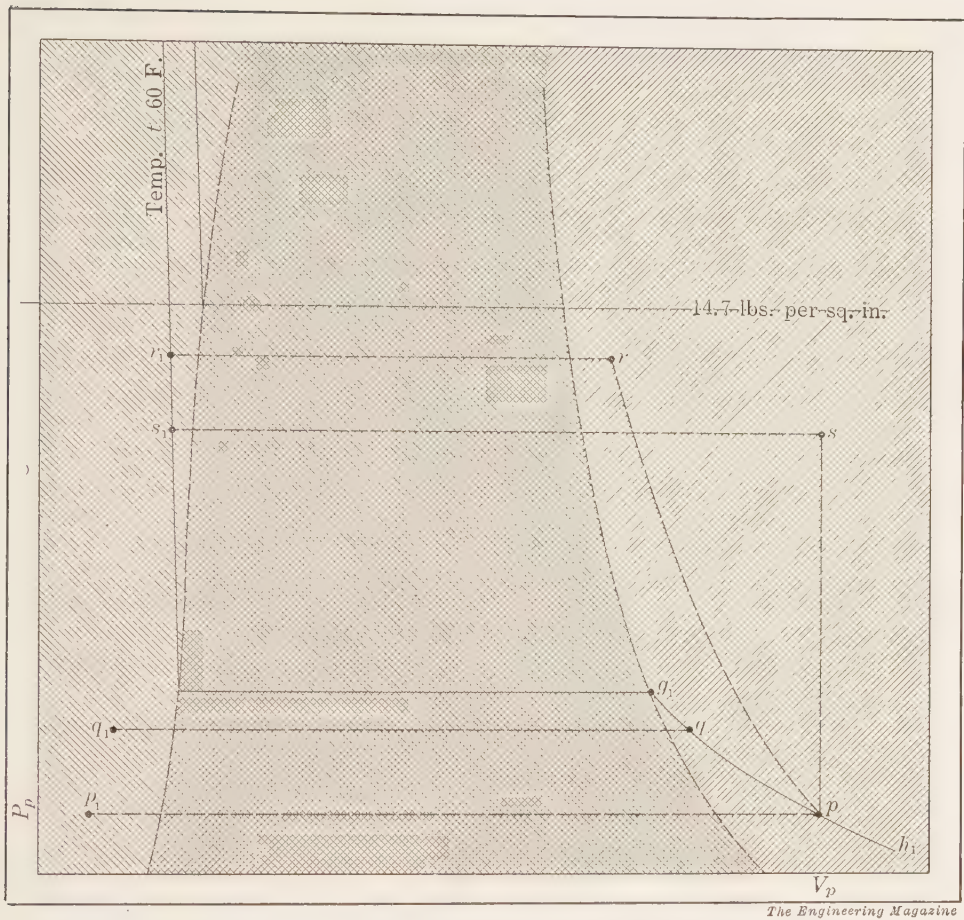


FIG. 4. PART OF FIGURE 3 WITH CHANGED PRESSURE SCALE

results in complete liquefaction of the vapor if carried far enough.

Or, the gas might be compressed by a process more nearly adiabatic; a method which would give the curve pr for the constituent X might be used in a real case. This compression would be accompanied by a rise of temperature as indicated by the fact that the curve crosses isothermals of successively higher temperatures. It then becomes merely a question of carrying the compression to such a point that the temperature has risen to a value so high that cooling with the available water can cause liquefaction, as, for instance, along the line rr_1 . As indicated on the diagram

water at 60 degrees F. could theoretically be used in this case.

It will be observed that this is substantially the process which is carried out in the apparatus shown in Figure 1.

It is the only process which has been widely used commercially, but this does not imply that it is the best nor the most economical. Two other possibilities will be described as an example of what might possibly be done in this field.

One of these methods is particularly startling because of its apparent unreasonableness. It would consist in heating the gas so as to cause a rise of pressure at constant volume.

It might easily be done by burning a small amount to heat a much larger quantity. The pressure rise for vapor X which we have assumed would be about as shown by the line ps in Figure 4. When the mixture has been brought to such a condition that the state of the vapor is as shown by point s , liquefaction can be effected by cooling at constant pressure along the line ss_1 , in about the same way as is now used commercially. No compressor is necessary with this method and yet the same result is attained.

Another possibility is to compress the gas approximately adiabatically to a high temperature, to cool it at constant pressure, and then to allow it to expand behind a piston so as to do work. It might, for instance, assist in compressing the gas which follows it through the process. If the vapor X has properties similar to those of steam it can be made to partly liquefy by this treatment; if, on the other hand, its properties are similar to those of ether, no liquefaction will take place. The data necessary to determine which action will occur are not yet available. If liquefaction could be brought about in this way it would be only partial, so that the process does not promise as well as that in use. It should, however, be observed that no cold cooling medium is needed; hot air might be successfully used. The process is therefore of interest as representing a possible way out of a case where cooling water is not available.

The calorific value of the gas will be lowered to a slight extent by removing the gasoline-forming vapors, but this is justified by the fact that it is generally possible to sell a given number of B.t.u. in the form of gasoline at a higher price than could be secured for the same heat value in the form of natural gas. It is also often necessary to remove some of

these vapors in liquid form before transmission of gas in pipe lines, as they condense out naturally during the compression of the gas, so that the installation of the simple machinery required to obtain the maximum yield of gasoline may result in perfecting a process already incompletely carried out.

The question whether such a plant should be installed in any given case must be answered on a dollars-and-cents basis. The possible yield of gasoline and the cost of producing it must be determined. The cost of production must, of course, include overhead charges of all kinds. With such data available a knowledge of transportation charges and market value determines the solution. The fact that the composition of natural gas from any one well sometimes changes erratically should never be lost sight of and it is best to allow a considerable margin of safety for this and other unpredictable contingencies.

The diagrams previously given also assist in visualizing the conditions which must be met in order that the liquid may be readily handled and transported. Let us first consider a quantity of liquid water in an open vessel. We know that with an atmospheric pressure of 14.7 pounds per square inch this water will boil if raised to a temperature of 212 degrees F. This means simply that the pressure of the saturated vapor of water is 14.7 pounds per square inch at a temperature of 212 degrees F. If the diagram of Figure 3 were drawn for water the horizontal part of the 212 degrees isothermal would pass through the mixed field at a height of 14.7 pounds.

Water could not readily be handled and transported commercially at this temperature, even if average atmospheric temperature happened to be 212 degrees F. The loss would be too

great because of the rapid evaporation. Any practical temperature of transport and handling must be below this value; the lower, within limit, the better. In other words, the nearer the temperature to the boiling point of the water the greater will be the loss.

Obviously any material can be commercially handled in liquid form with least loss when the temperature at which the pressure of its saturated vapor is equal to that of the atmosphere is very high as compared with average atmospheric temperature. The relation of temperature and pressure is well shown by the diagrams given.

Such diagrams drawn for the different constituents of the gas which can be liquefied to form the mixture known as gasoline will indicate the

relative ease of handling. If any of the constituents show that the isothermal crossing the mixed field at a pressure of 14.7 pounds has a temperature near that of the atmosphere, that particular constituent will form a very volatile liquid and, if it occurs in large quantities, will give similar properties to the mixture of which it will form a part.

Ordinary gasoline of good quality behaves in such a way that if it consisted of but one chemical compound the 150 degrees isothermal would cross at 14.7 pounds and the 60 degrees isothermal at a height of about 0.2 of an atmosphere. This material can be handled without difficulty at ordinary temperatures, but evaporation is rapid enough to necessitate closed vessels when the liquid is to be carried any great distance.

PRINCIPLES OF FIRE-RESISTING CONSTRUCTION FOR INDUSTRIAL PLANTS

By F. P. Walther

In an article in the August issue of THE ENGINEERING MAGAZINE the proper arrangement of a manufacturing plant to prevent the sweeping fire was discussed. The urgent necessity for dividing the plant both horizontally and vertically into separate sections in order to prevent destructive fires was shown, and the methods of accomplishment were given. In this paper the principles of both fireproof and so-called mill or slow-burning construction from the fire viewpoint will be taken up.—THE EDITORS.

THE best form of factory construction, and the one that is rapidly becoming the most economical, all things considered, is without doubt the fireproof building. The increasing price of lumber used in the construction of buildings with wooden interiors and the economies that are being introduced in fireproof construction are reducing the difference in the first cost of the two types. In fact, that difference today ordinarily amounts to but 10 to 15 per cent and is often less. When the

permanency of the building, the difference in maintenance, and the decreased wear and tear on the machinery due to the rigidity of the fireproof construction, are taken into consideration, to say nothing of the smaller fire hazard, the fireproof building is actually the cheaper.

Before discussing the principles of fireproof construction it may be well to establish plainly just what the term "fireproof" in this connection means, for there is no word in building construction which is so fre-



CHARACTERISTIC FAILURE OF TILE

quently misapplied as this one and about which there seems to be such widespread misunderstanding. The term "fireproof" in building construction means a capability of withstanding fire without being materially damaged. A fireproof building, therefore, may be defined as one that is capable of having its contents cremated without material impairment structurally. That is, all burnable material may be destroyed but the structure itself will remain intact, requiring only the replacement of some of the fireproofing and the interior finish to make it again ready for occupancy.

Many people think that the term "fireproof" is a misnomer, that there is no such thing as a "fireproof" building, and that the use of the term gives one too great a sense of security. This attitude has been brought about largely by the destruction or serious damage of certain buildings that were supposed to have been fireproof, and by the fact that many people think because a building is fireproof it should in some occult fashion prevent the con-

tents from burning. It is a matter of record that where buildings called fireproof have been destroyed they have been found to have violated some fundamental principle of the really fireproof building. A fireproof building must be considered apart from its contents, for the structure itself can in no way prevent the burning of combustible material within it except insofar as it may be designed to prevent the spread of fire. It is true that as yet we have not attained the absolutely fireproof building, since even the best fireproofing material we have today is somewhat damageable by fires, but we can and do erect structures that are practically fireproof.

The term "fire-resistive" is sometimes used in place of "fireproof" in an attempt to find a more suitable term. It is a poor substitute. Cloth and other combustible material may be treated with chemicals and given the property of resisting fire to a certain degree, that is made "fire-resistive," but they will still burn if subjected to sufficient heat. Wood may be covered with

asbestos board, plaster on wire lath, or other non-combustible material, or even painted, and as a result will resist fire for a limited length of time. It will then be "fire-resistive" but far from "fireproof."

Modern fireproof buildings are of two general types—the skeleton steel-frame building and the reinforced-concrete building. As its name implies, a skeleton steel-frame building is one having a skeleton

sist the tensile and shearing stresses of the structure.

The development of the modern fireproof building, like most industrial achievements, has been gradual, and it has been largely through the agency of actual fires that the principles involved have been determined. In the first days of such construction any incombustible material, particularly iron and steel, was looked upon as being also fire-

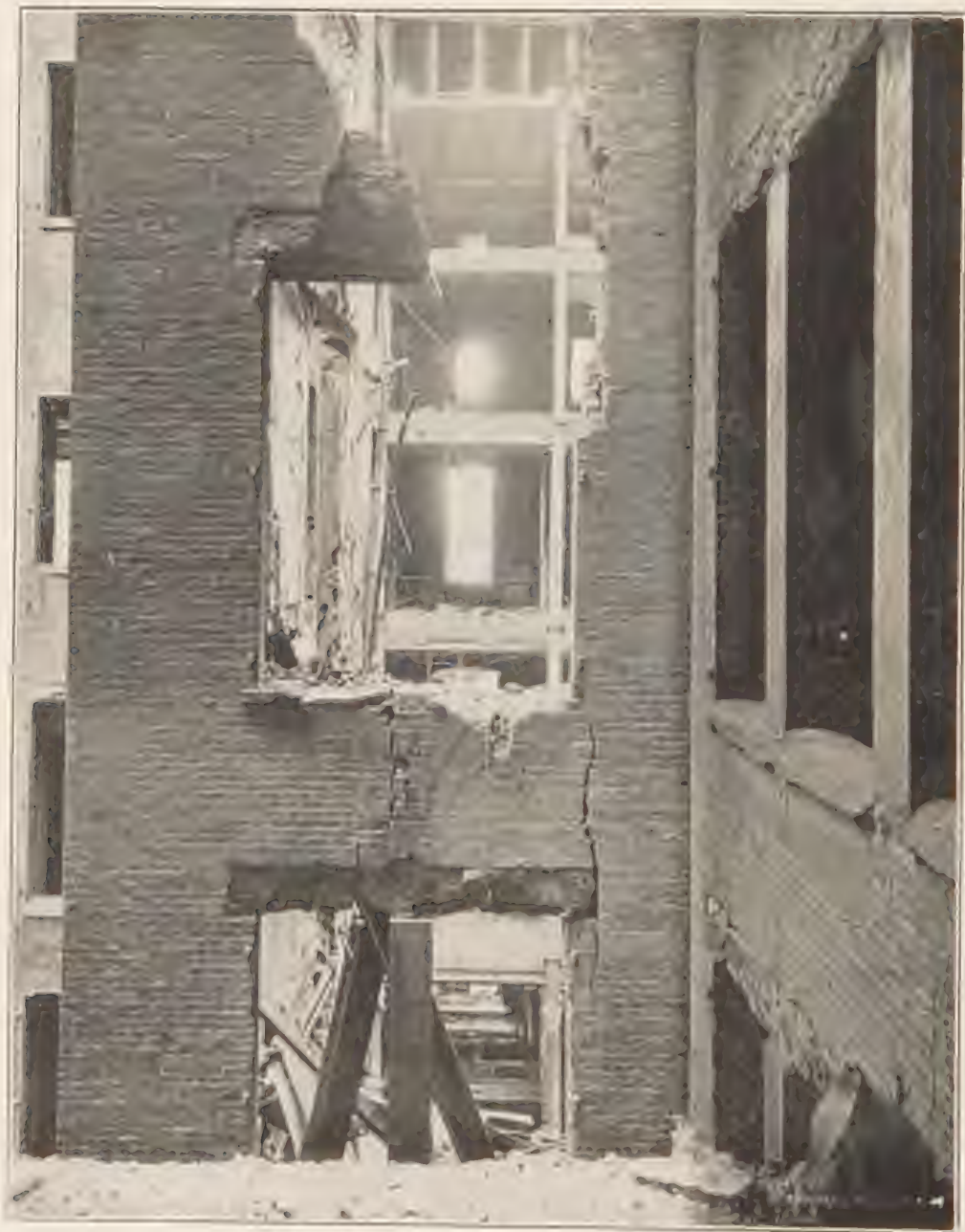


AN EXAMPLE OF THE SPALLING OF STONE FACING

framing of steel, which carries the walls and floors. This consists of I-beams, channel irons, and other shapes, all securely riveted and bolted together. In the early buildings of this type, cast-iron columns were generally used, but these are seldom employed today except in low buildings. A reinforced-concrete building is one in which the rolled-steel shapes are replaced by columns, girders, and beams made of concrete containing steel rods or bars to re-

proof and all that was deemed necessary in order to construct a fireproof building was to use incombustible material. It took numerous fires to teach the fallacy of this and to demonstrate the fireproofing qualities of the various building materials.

That iron and steel are not fireproof is attested to by the tangled wreckage after a fire in a building in which the metal structural members were not properly enveloped in some fireproof material. Structural steel



FAILURE OF UNPROTECTED CAST-IRON WINDOW LINTELS AND SPALLING OF STONE FACING ALLOWED CAST-IRON MULLIONS TO FALL OUT AND CAUSED THE WALL TO FAIL

loses its rigidity at comparatively low temperatures, about 1,100 degrees Fahrenheit, and cast iron at about 1,300 degrees, whereas the temperature of the average fire is about 1,700 degrees and many are

considerably hotter, so that if subjected to even an ordinary fire, steel or cast iron will collapse in a short time.

As the use of steel is of great economic value, in fact its development

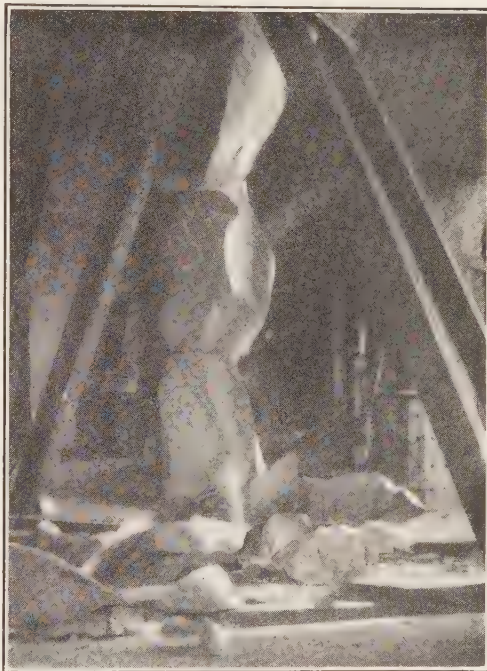
has made the fireproof building, especially the skyscraper, a commercial possibility, the problem of the fireproof building has been to find materials and methods by which structural steel might be so insulated as to make it proof against fire. Experience has demonstrated that certain materials have better fireproofing qualities than others.

Studies of the ruins of conflagrations, as well as of many other fires, have shown conclusively that hard-burned brick forms the most efficient fireproofing material we have at the present time. This seems to be due both to the homogeneous texture of brick and to its small size. The hardest burned brick may spall somewhat on the outer face, but the face next to the steel does not heat dangerously and the numerous joints relieve to a great degree the effects of expansion. Unfortunately brick is the most expensive kind of fireproofing.

Terra-cotta blocks are used extensively for fireproofing. There are three general classes in use, known as the "dense," "porous" and "semi-porous." For fireproofing work the semi-porous tile is the most satisfactory. When it is properly proportioned, compact, tough and hard and gives a metallic ring when struck with metal, it will withstand the effect of heat to a great degree. Much of the commercial tile, in an attempt to meet the demand for cheapness, is made with too thin webs and the angles where the webs join the shell are not properly rounded. As a result, in actual fires the outer or lower face of the tile breaks off, not being of sufficient strength to withstand the unequal expansive forces between the shell and the webs. This dropping off of the lower face may cause the complete failure of the fireproofing. It is therefore "penny wise and pound foolish"

to skimp on tile fireproofing. The large size of the individual tile is an additional cause of failure of tile fireproofing. Accompanying illustrations show characteristic failures in tile fireproofing.

Concrete is rapidly coming to the fore as a fireproofing medium and as a common material in building construction. It has many marked advantages and also several serious



COMPLETE FAILURE OF A HEAVY STONE PIER

drawbacks. It owes its strength to the hydration of the cement, which, in setting, takes up a certain amount of water of crystallization. At temperatures above 600 degrees Fahrenheit this water begins to be driven off and the cement loses strength. When the dehydration is complete the strength of the cement, or concrete, is practically destroyed. However, dehydrated-concrete is a poor conductor of heat and therefore the process of dehydration in the interior of the mass is slow. The length of time the dehydrated material will remain in place and retard the pro-



CHARACTERISTIC FAILURES OF COLUMNS

On the left, a badly buckled steel column. On the right, a cast-iron column in which the thickness of the metal was $\frac{1}{2}$ in. on one side and $1\frac{1}{8}$ in. on the other. Its installation was due to poor supervision

cess of dehydration will depend somewhat on the force of the hose streams used to extinguish the fire. In actual fires concrete has been destroyed in this manner to varying depths of one-half inch to two inches.

The richness of the concrete mixture has a very marked effect on its efficiency as a fireproofing material. The ideal mixture is one containing sufficient cement to coat thoroughly each piece of aggregate, the quantity of sand being just sufficient to fill the voids between the coarser aggregate. Generally speaking, one part of cement, two of sand and four of the coarser aggregate fulfil this condition. As the purpose of the cement is to form a binder for the aggregate, thorough mixing is necessary. This is best accomplished in a machine designed for the purpose and each batch should be turned over an adequate number of times to accomplish the desired result. Just sufficient water should be used to make the mixture flow properly, so that when spaded or tamped into place all the interstices will be completely filled. If too much water is used the result will not be uniform and if too little is used the concrete will not flow into place properly and voids are apt to be left, which hastens the destruction of the concrete in the event of fire. Also, if too little water is used, it is questionable whether the cement will be properly hydrated, thereby affecting the strength.

The best coarse aggregate to be used in concrete work from a fireproofing standpoint is one that is capable of withstanding fire, such as well burned furnace clinkers, broken brick, trap rock, and similar materials. Care must be exercised in the selection of cinders to see that they are clean furnace cinders, reasonably free from particles of unburned coal.

Those from locomotives and gas works are wholly unsatisfactory. Cinder concrete makes excellent fireproofing, but a grave fault is its lack of waterproofness. It is unreliable from the standpoint of strength, so that when the concrete is to be used in wall and column construction, a stone aggregate must be used. Stone concrete is a good fireproofing material although it is subject to spalling in a fire and through this defect often exposes the steel. Whatever coarse aggregate is used it should be of a size which will pass through a 1-inch ring. This is important, for with the use of a larger aggregate the danger of voids being left in the concrete is increased.

Stone is practically worthless as a fireproof material and its use as a trim or facing should be avoided whenever possible. Granite will explode and fly to pieces or disintegrate into sand when exposed to flames, since it contains sufficient water in hygroscopic form to make steam under heat. The limestones and marbles are usually ruined if not wholly destroyed by an ordinary fire. Fine-grained sandstone will withstand a moderate fire but cannot be depended upon.

Plaster on wire lath or expanded metal is sometimes used as a fireproofing material, which is satisfactory only to a limited degree, as the slight thickness of the plaster enables the heat to reach the metal quickly. Also, heat disintegrates the plaster, which cannot then withstand the application of hose streams.

The columns or vertical supports of a building, really the keynote to the skeleton structure, are the most important members to be protected. The reason is readily apparent, for if a column on one of the lower floors buckles, it will permit the settling, and perhaps collapse, of all the floors

above it; so that extreme care must be exercised in the fireproofing of columns.

As brick is the best fireproofing material, it constitutes the best column protection. It should be at least one course, or four inches thick, the brick to be laid flat.

If tile is used it should consist preferably of two courses, each at least two inches thick, set up with

In the use of either brick or tile fireproofing the space between the fireproofing and the steel should be flushed full with a cement grout. This grout not only gives added protection against fire but also serves as an excellent rust preventative.

Where concrete is used for column protection in the steel-frame building, the minimum thickness that should be considered is 3 inches, as it is likely to be destroyed by fire to a depth of $1\frac{1}{2}$ to 2 inches; 4 inches would be much better, in fact 4 inches is imperative if the building is to house much combustible material. In a great many fireproof buildings, the electric conduits and steam and water pipes are embedded in the fireproofing on the columns. On first thought this appears to be a convenient method of getting rid of these unsightly features, but experience has shown it to be a disastrous practice. This is due to the fact that these pipes are not adequately protected and their expansion in case of fire strips the fireproofing from the column. An accompanying photograph illustrates this feature. The proper method is to construct pipe channels or ducts independently of the fireproofing of the steel. These may without detriment adjoin the column protection.

There are many different styles of floor construction in use in steel-frame buildings, some being patented systems. They consist variously of arches of brick, tile, a combination of tile and reinforced concrete, and solely of concrete, placed between the I-beam floor framing. The arches may be curved (segmental) or flat. Tile arches are also styled as either "end-construction" or "side-construction," depending upon whether the air spaces in the tile extend at right angles to the beam or parallel thereto.



AN EXTREMELY POOR TYPE OF STEEL COLUMN

broken joints both vertically and horizontally. The inner course should be thoroughly wrapped with heavy wire, the wire to be put on in such a manner that every block will be crossed at least once. Then when the outer covering fails, which it will do if the fire is at all severe, the inner layer will remain in place and protect the column. A single tile covering is fairly satisfactory if it is at least three inches thick and the shells and webs are at least one inch thick. The single covering should also be thoroughly wrapped with wire.

It is not within the scope of this article to go into the details of floor-arch construction. Whatever style of arch is used, the most essential feature from the viewpoint under discussion is to see that it adequately protects the steel beams. In the brick, side-construction tile or reinforced-concrete arch, the arch construction itself forms an adequate protection for the side of the I-beam provided the top of the arch is filled in with concrete or other fireproofing material to above the I-beam. In the end-constructed tile arch, however, it is essential that in the row of tile next to the I-beam, called skewbacks, the air spaces run parallel to the beam; otherwise a portion of the beam will be exposed should the lower face of the tile break off.

Segmental tile arches should have at least two cellular spaces in the vertical height of the arch and flat arches at least three. The thickness of the shells ought to be at least $\frac{3}{4}$ inch and the webs $\frac{5}{8}$ inch; 1 inch and $\frac{3}{4}$ inch, respectively, would be much better, and are imperative for skewbacks.

In the early types of fireproof buildings, particularly in those of brick-arched construction, the underside or soffit of the I-beams was left either entirely unprotected or protected by plaster only. Today in good construction the lower surface is protected by 2 inches of either solid tile or concrete. At first metal clips were used to hold this tile in place, but it was soon found that when subjected to fire these weakened and allowed the tile to drop off. In modern construction, therefore, the skewbacks are either so shaped as also to protect the under side of the I-beam or else are beveled so as to hold an extra piece in place. When concrete is used for the fireproofing of the under side of steel beams it

should be well anchored to the I-beam by means of suitably designed interior steel anchors so embedded as to be properly protected from fire. The use of light wire for this purpose should not be allowed.

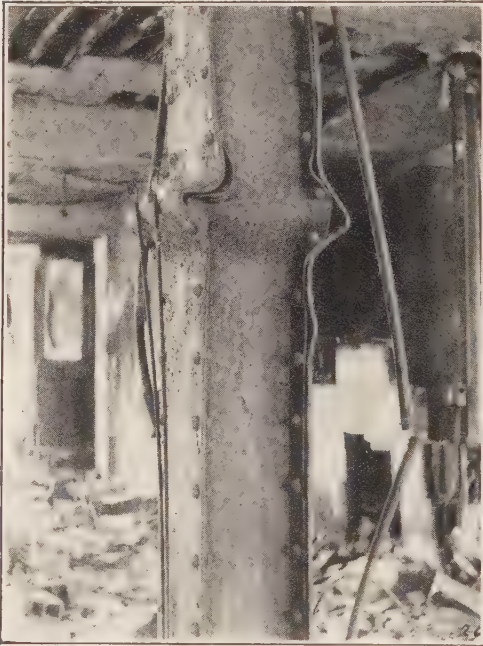
The reinforced-concrete building if properly planned from a fire standpoint will be designed first in regard to strength and then an extra thickness of concrete added to the columns, girders, beams and under side of the floor slabs solely for fireproofing purposes. It is just as important to fireproof the reinforced-



PARTIAL FAILURE OF AN UNPROTECTED CAST-IRON COLUMN

concrete structure as the one made of steel, a point which is not always fully appreciated. In the writer's opinion the minimum thickness of this fireproofing coat in buildings designed for the housing of combustible contents should be 3 inches on columns, $1\frac{1}{2}$ inches on the girders and beams, and 1 inch on the under side of the floor slabs. In case of fire the chances are that the con-

crete will not be destroyed for greater depths than these and consequently the strength of the building will not be impaired. It is practicable to replace this damaged concrete fireproofing and thereby renew the fireproof qualities of the structure, but



COLUMN FAILURE CAUSED BY PIPING ENCLOSED IN THE FIREPROOFING
Note the broken tile, top of picture

it is impossible to replace concrete in this manner and depend upon it for strength.

While at the present time it is customary to finish fireproof buildings with wooden floors and combustible trim, the concrete or other non-combustible floor finish and metal trim are rapidly coming into vogue. Certainly the less combustible material there is in a building the better will be the outcome in case of fire and the more nearly the building will be "fireproof." When wooden floors are used there should be no space between them and the fireproof floors.

As previously stated, no matter

how well constructed a fireproof building may be, it cannot in itself prevent the contents from burning; but it can be so planned as to assist in preventing the fire's spread. This is accomplished by dividing each floor into as many parts, by means of fireproof partitions, as the nature of the occupancy will permit, and by cutting off one floor from another. Such partitions should of course be constructed of fireproof material and not rest upon or be held in place by any combustible material; that is, they should extend from the fireproof floor arch to the ceiling arch. If windows are necessary in these partitions they should be of wired glass set in metal frames and all doors should be fire doors. The proper protection of stairways, elevators and other openings was discussed in the August paper. Fires frequently extend from one floor to another by way of the windows in the enclosing walls, so in order to effect an absolute floor to floor cut-off it is also necessary to protect all window openings, either with wired glass, shutters, or both.

The matter of making the floors waterproof is an important feature commonly overlooked. If the floors are not waterproofed and proper drainage is not provided, even a small fire on one of the upper floors may cause a heavy water damage to the contents of the lower floors.

Whether the building is of skeleton steel or reinforced concrete, the matter of workmanship is of prime importance and receives too little attention in this commercial age. If tile is used for the fireproofing it should be seen to that only whole tile are used, that the joints are well set up with portland-cement mortar, and that the fireproofing subsequently remains unbroken. There are cases on record where it was found after a



A SERIOUS FAILURE

Unprotected steel at the roof collapsed, letting a large tank plunge through the building carrying everything with it. This falling tank was largely responsible for the failure of the fireproofing on the lower floor

destructive fire that in suspending a false ceiling or in attaching other interior finish the workmen had seriously broken the tile. Is it any wonder under such conditions that a building which is supposed to be fireproof fails under the crucial test? Even after the building is completed the fireproofing is often knocked from a steel member, either accidentally or to accommodate some change in machinery, piping, and so on, and proper care is not always taken to replace it. This is a serious mistake as it leaves the steel open to the attack of fire. Where there is much trucking done or there is danger otherwise of the column protection being injured, it should be thoroughly protected by means of a metal jacket or similar shield.

The reinforced-concrete building requires even closer supervision during construction than the steel frame building as the chances for dishonest or careless work are more numerous, and, in addition, the class of labor employed in its construction is generally that of the common laborer, usually foreigners. It is real economy to employ a competent and well trained inspector to keep watch over the details of its construction. It must be seen to that the forms are cleared of all combustible material before any concrete is poured into them; that the reinforcing steel is placed in accordance with the design and that it does not become displaced, as carelessness in this regard has been the cause of more than one collapse; that



SPALLING OF CEMENT FROM CONCRETE COLUMNS

Note, in the lower cut, the exposed reinforcement and the bracing put in on account of fear of collapse.

Later tests showed the strength of columns and beams to be but slightly impaired, and replacement of surface cement only was necessary

Courtesy of the Boston Manufacturers Mutual Fire Insurance Co.



FAILURE OF UNPROTECTED STEEL IN A BUILDING OF MACHINE SHOP TYPE, CONTAINING BUT LITTLE COMBUSTIBLE MATERIAL

Courtesy of Insurance Engineering

the quality of the concrete is up to requirements; that the concrete is properly spaded or tamped into place so that no voids are left; and there are other points which require close supervision.

Next to the fireproof building the best types of factory construction is the mill-constructed building. The term "mill construction" is applied to a class of buildings which have heavy plank floors carried on heavy wooden timbers. The walls are sometimes of similar construction to the floors but ought to be of brick or concrete. It was originally developed in New England in connection with the textile industry by the factory mutual fire insurance companies of that section. It is also called "slow-burning construction" in view of the fact that a building of this character, if correctly designed, burns slowly. To be true to its name of "slow-burning" it must comply with the following requirements:

First: There must be as few angles or corners as possible in the floor construction for a fire to attack. This is accomplished by using very heavy floor timbers spaced eight to twelve feet apart, with floors of three or four-inch plank, either tongued and grooved or splined to form a close floor.

Second: There must be no concealed spaces in which a fire may gain headway or spread and be out of the reach of the fire-fighting apparatus. This means that the ceilings must be left open, or if a finish is necessary it must follow the contour of the beams.

Third: The cut-offs between the floors must be effective, the means of accomplishing this were given in the August paper.

Fourth: The floors must be tight, so as to prevent fire, smoke or water from working through. This is usually accomplished by placing water-proof paper between the light wear-

ing floor and the heavy plank floor. This paper should be well flashed up at the posts and walls. The floor itself must be pitched to scuppers at the side walls, or other means provided to carry off the water. Frequently the stair or elevator shaft is utilized for this purpose.

It is a well known fact that it is difficult to start the smooth, flat surface of a heavy timber burning. Therefore, the fewer corners or angles there are in the wooden floor

better than one of ordinary construction, for even heavy wooden timbers will burn rapidly under the conditions of draft which then exist.

The most satisfactory timber for the mill-constructed building, and that most generally used, is long-leaf yellow pine. This is becoming scarce and very expensive, particularly in the larger sizes, and in an attempt to lower the cost twin beams are often used. Such practice is not satisfactory for in order to prevent



THE TANGLED WRECKAGE OF AN ELECTRIC POWER PLANT

construction of a building the more difficult it will be for a fire to gain a hold. Another advantage of the mill type of building is that the wide open bays forming the ceiling, in contradistinction to the numerous narrow joist channels of the ordinary building, greatly facilitate the application of water in case of fire, either from hose streams or automatic sprinklers. It is absolutely essential for a building of this class to have its floors well cut off from each other. If this precaution is neglected the building will be little

what is termed dry rot it is necessary to separate the two pieces about $\frac{1}{2}$ inch and this forms a space in which it is extremely difficult to extinguish a fire. Fire has been known to smolder in this place for a considerable time, gradually eating its way through the timber. Another practice that is followed in an attempt to cheapen the result is to substitute steel beams and columns for wooden timbers, generally without any fireproofing. It is of even greater importance that steelwork be protected in a building of this

type than in one of non-combustible construction.

The best practice is to leave mill timbers unpainted, but if painted, a fire-retardant paint should be used and before painting a sufficient length of time should elapse to season the timbers thoroughly (ordinarily one to two years), otherwise dry rot is likely to be induced. Besides seriously affecting their strength under normal conditions timbers attacked by dry rot fall an easy prey to fire. A few years ago a mill-constructed building in New York City collapsed after a fire which apparently had burned the timbers only moderately. Upon investigation for the reason of the collapse it was found that the tops of the posts had been attacked by dry rot, probably due to the iron caps not allowing the moisture to escape, and these were badly burned. To obviate this danger several holes of small calibre should be bored in two directions through the posts near the top. Another danger point from dry rot is where the beams and girders enter the walls. To overcome this danger a small air space should be left around the timbers.

As one of the fundamental principles of the mill-constructed building is to use in its construction only heavy, slow-burning material, the use of light wooden partitions should not be allowed. Necessary partitions should be of heavy planking without concealed spaces, or better, of non-combustible material.

A common type of factory build-

ing found throughout the country is one constructed in whole or part of unprotected structural steel. The roofs sometimes are made solely of metal but more often they have wooden roof boards. The enclosing walls are variously of brick, concrete, metal or wood, the latter being generally covered on the outside with metal. The building constructed entirely of non-combustible material is reasonably satisfactory for steel mills, foundries, machine shops, and other occupancies in which the contents are non-combustible, but it is a poor type for the housing of combustible material. In fact, the burning of wooden roof boards alone has proved sufficient heat to cause the collapse of steel roof trusses.

For the housing of combustible materials the building of true mill construction is vastly superior to that of non-combustible construction with unprotected steelwork, but it is in the fireproof building that the manufacturer gets his maximum return. While it may seem in this discussion that the faults of fireproof materials have been almost too strongly emphasized, this has been done with the view of showing prospective builders these points which require their closest supervision. By proper design and execution it is both possible and practicable to erect buildings that are fireproof for all commercial purposes, but by careless workmanship or an attempt to erect a building too cheaply the result should a fire gain headway in the structure will be disappointment.

(To Be Concluded)

CONSTRUCTION AND OPERATION OF TURBO-BLOWERS AND COMPRESSORS

By Franz zur Nedden

III. THE DESIGN OF IMPELLERS

Mr. zur Nedden's discussion of the mechanical evolution and operating economy of turbine machinery began in our July issue. The preceding parts have been devoted to the "Fundamental Principles of Turbo-Machine Design," and "Temperature Effects and Cooling Devices."—THE EDITORS.

BEFORE a practicable turbine blower could be designed, a really practical impeller design must have been determined. The development of the steam turbine, indeed, had already brought forth a series of forms for discs running at very high circumferential velocities; but the problem with which the designers of turbine blowers found themselves confronted differed in one very essential point from that already solved.

C. A. Parsons was able simply to adapt the form of his steam turbine runners to his turbo-blower, whereas all other designers, taking the centrifugal pump as their example, had to produce an *unsymmetrical* runner.

As the center of gravity, G , Figure 14, by which the centrifugal force, P , seizes the blades and the left-hand flank, is not concentric with the main sheave A , it creates a bending moment, $P \times L$, which tends to deform the wheel as suggested in the dotted lines. It is very interesting to see that Prof. Rateau and C. H. Jaeger both finally reached the same solution—*i. e.*, an impeller made up of a solid hub, with blades and lateral flanks made of pressed sheet nickel—and this, although both experimented first with solid impellers.

SOLID IMPELLERS

Figure 15-A shows one of the first impellers used in the Rateau blower,

which, by the way, is still working at Rothe Erde, near Aix-la-Chapelle. It is made absolutely symmetrical, in the form of a double impeller, revolving with a peripheral velocity of

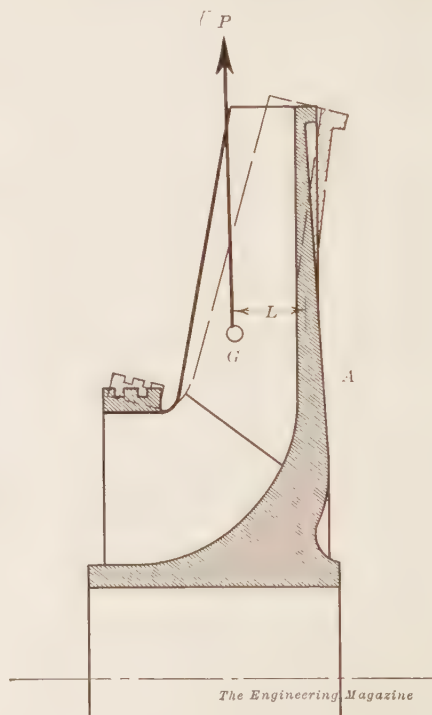


FIG. 14. DEFORMING TENDENCY OF ECCENTRIC CENTRE BY GRAVITY

750 feet per second and sucking the air from both sides.

Apart from the mere constructional impossibility of joining several of these impellers in series in a single casing, (at least without much com-

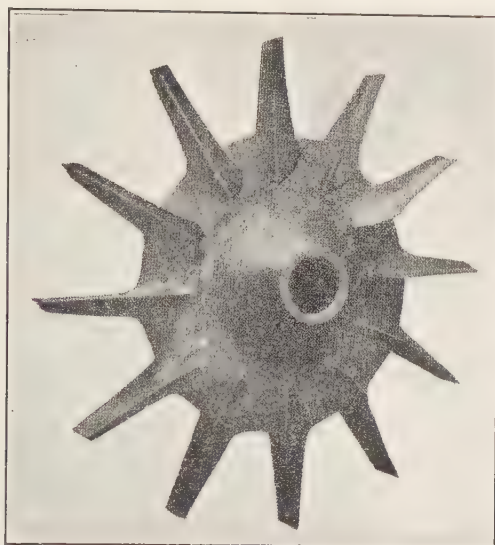


FIG. 15 A. ONE OF THE FIRST IMPELLERS DESIGNED BY BROWN, BOVERI & CO.

plication) the design is expensive, and would have raised the price of the whole machine so high that it probably would not have been able to meet competition.

Figure 15-B shows one of the first experimental impellers designed by C. H. Jaeger. It is also made of solid nickel steel, machined throughout, the blades being polished and cut out with the utmost care on special milling machines.



FIG. 15 B. EXPERIMENTAL IMPELLER, C. H. JAEGER'S DESIGN

BUILT-UP IMPELLERS. RIVETED IMPELLERS

In later experiments both inventors turned to built-up runners. The flanks of these impellers are made of laminated nickel steel of the best quality and are riveted together cold. Figures 16 and 16-A show photographic views and sections of runners made by licensees of Prof. Rateau. Figures 17 and 17-A represent similarly an impeller designed and patented by C. H. Jaeger.

Prof. Rateau and his licensees tried to overcome the difficulties of the problems presented by the physical distorting moment mentioned

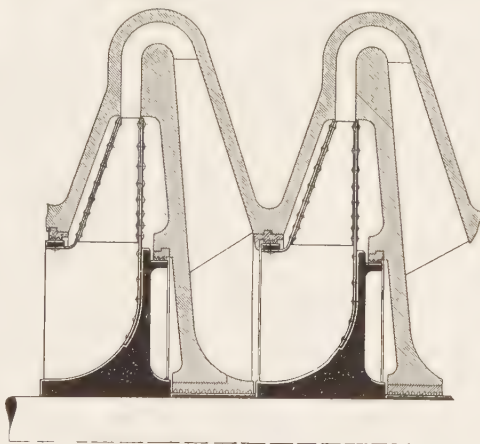


FIG. 16. RATEAU IMPELLERS
Brown, Boveri & Co.

above, by extending the hub into a very strong sheave which forms the interior flank of the impeller. Though this design is doubtless quite safe and gives excellent results in hundreds of machines, the Jaeger design appears to solve the same problem in a more ingenious manner. The principle of the patent obtained by him is the special mode of fixing the internal riveted body to the hub. The flank is fixed to the hub by means of a few small screws and a nut; both prevent it from slipping laterally or in the direction of the rotation, but at the same time allow every facility

for the sheave to expand radially. Thus, the body of the impeller expands as a whole in a strictly radial direction without causing the characteristic bending stresses or deformations heretofore referred to. The flank and blades of the Jaeger impellers, furthermore, are thickest near the hub, tapering toward the periphery, thus forming sheaves of maximum resistance against centrifugal deformations, like the well-known steam-turbine runners.

sembling built-up impellers, even of the largest dimensions, would be to weld the sides and blades seamlessly together. Serious consideration has been given to the idea of adapting the new autogenous welding process to the construction of these runners.

FORM OF BLADES

Another difference of opinion arises over the question whether guide blades are or are not objectionable. Strangely enough, the same

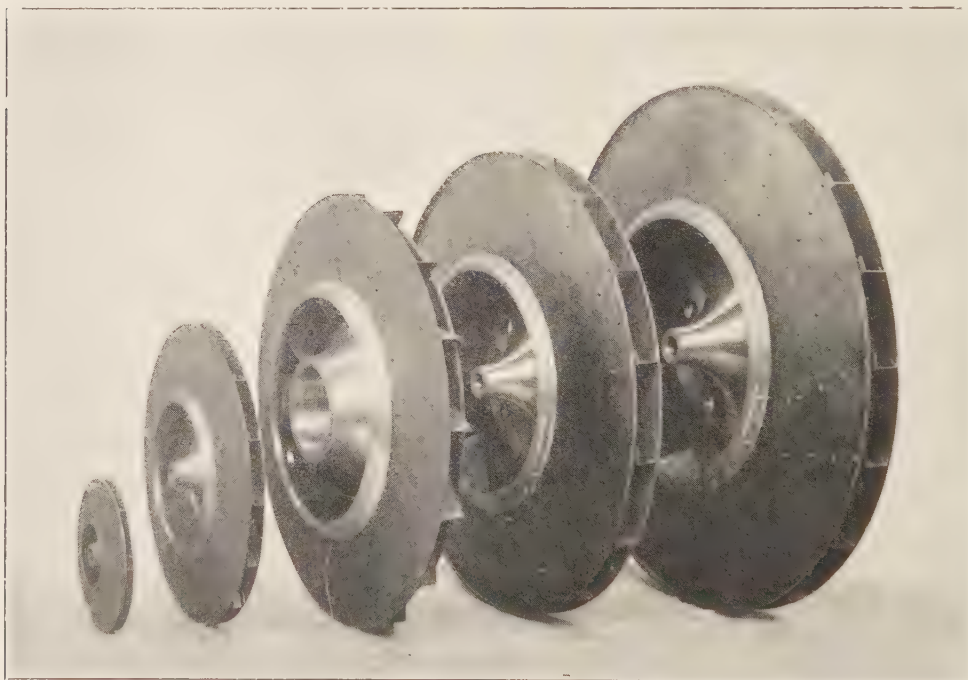


FIG. 16 A. RATEAU IMPELLERS
Brown, Boveri & Co.

Makers seem to differ widely on the question whether the rivet heads projecting from the external flanks of the impellers create serious frictional resistance. Jaeger sinks the rivets carefully and turns the flanks off and polishes them, as suggested in Figure 17, whilst Kuehnle, Kopp & Kausch, Brown, Boveri & Co., and the majority of the licensees of Prof. Rateau, leave the impeller as shown in Figure 16A.

Perhaps the best process for as-

manufacturer who carefully polishes the impellers as smooth as possible does not hesitate to provide a guide for the diffuser; whilst Prof. Rateau, after extended and careful experiments to determine the maximum efficiency obtainable with diffusers of various shapes, has reached the final conclusion that guide blades add less to mechanical efficiency than they take from the thermic efficiency, because of the friction and consequent heat which they cause.

Still another striking difference between the manufacturers of Ra-teau and Jaeger impellers is that Jaeger uses curved blades, whereas Ra-teau recommends his licensees to adopt straight blades. It seems, in-

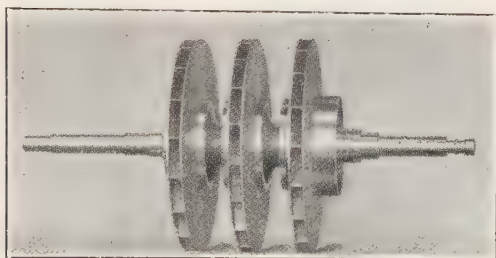


FIG. 17. C. H. JAEGER'S PATENTED IMPELLER

deed, somewhat doubtful whether the advantages which surely attend curving of the blades (because the designer is thus enabled to obtain correct angles for the suction) outweigh the complication of manufacture which is involved. These doubts are increased when we consider the inevitable faults with respect to the width and angles of the impellers and guide wheels, to which the designer is driven by purely manufacturing reasons. As the air is gradually compressed by the impellers, the widths and angles of the blades and channels should correspondingly vary; at least this appears to be so when the matter is regarded from a merely theoretical point of view. From the manufacturing point of view, however, it is quite clear that the only concession that can be made to this theoretical demand would be a gradual decrease of the breadth of the impellers in an axial direction, while the diameters and entrance angles remain the same. This practice is followed by some turbine-pump makers in order to vary the output of machines from one and the same pattern. But the adaptation is undoubtedly improper in theory.

In this dilemma, the designer of turbo-compressors is held down to the necessity of confining the number of stages in a single casing to the fewest possible, and therefore we find in general practice that within any one group, the same diameter, width, and angles are maintained throughout.

This confinement to a few stages per group is dictated by the limitation imposed upon the designer by the consideration of the critical speeds; for in machines of these high velocities and small clearances the critical speeds become of the foremost importance. It is therefore not considered good practice by leading manufacturing firms, at least in blowers of more than 50 brake horse power, to join more than seven or at a maximum eight stages on one shaft, and consequently not more than eight stages in one group.

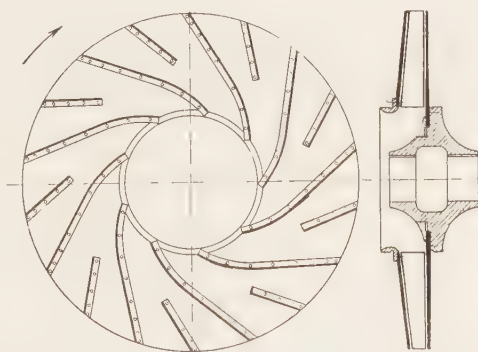


FIG. 17 A. C. H. JAEGER'S PATENTED IMPELLER

BALANCING

The runners of centrifugal blowers must be balanced to a much greater nicety than is necessary in turbine pumps, as the running speeds are generally higher than the speeds employed in turbine-pump driving. Figure 18 gives an idea of the minute balancing process to which these runners are subjected on a specially designed weighing apparatus.

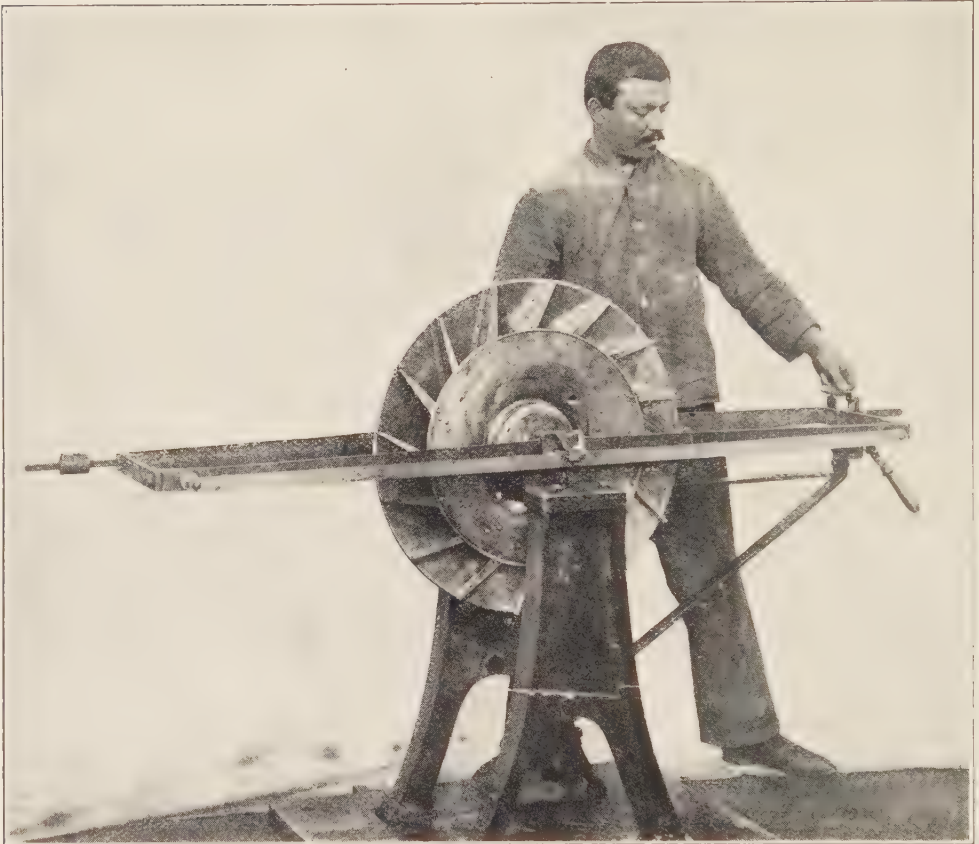


FIG. 18. SPECIAL WEIGHING APPARATUS FOR BALANCING TURBO IMPELLERS OF THE RATEAU TYPE
As developed by Kuhnle, Kopp & Kausch

PREVENTION OF LEAKAGE

It is not very difficult to insure tightness between the single stages of turbo-blowers and turbo-compressors. The pressure differences against which the clearances have to be kept tight are comparatively small, as the delivery pressure is distributed over many stages; and, on the other hand, long clearances are secured almost automatically as the stages are placed one after another in the casing. With air, as with water, the leakage resistance of a clearance is greater the longer and narrower it is, but the problem of maintaining tightness against leakage, with gaseous media, is facilitated by the labyrinth effect which is utilized on a

large scale in the manufacture of steam turbines.

Figure 19 shows such a labyrinth as used by Brown, Boveri & Co., the action being briefly described thus:—

The air passing through the small clearance, *A*, expands as it enters the following chamber, *B*. By this expansion its pressure is greatly decreased, and it traverses the second clearance *C* at a considerably lower pressure than that at which it passed through *A*; owing to the expansion in the second chamber *D*, still less pressure is left for forcing the air through the third clearance *E*, and so on, and it is therefore impossible for any considerable quantity of air to pass the labyrinth.

BALANCING AXIAL THRUST

The only point at which any great loss of air occurs is in connection with the usual methods for balancing the axial thrust. Special arrangements for this balancing become necessary, for, as with centrifugal pumps, the angular area opposite the entrance to each impeller is subject to a heavier pressure than the entrance itself. And, as with centrifugal pumps, there are several ways of obtaining perfect balance, perhaps the best being that illustrated in Figure 20.

BALANCE BY COUNTER-POSITION

Here the blower draws the air from both sides, and delivers it after both halves of the entire quantity have been compressed separately in wheels of the same dimensions through which they pass in opposite directions. Thus, any axial thrust arising in a wheel on one side is balanced by an equal thrust exerted by a corresponding wheel on the other side. This advantage of balancing

axial thrust most perfectly, and practically without any leakage losses, is paid for, however, in this instance by a cumbersome arrangement and poor efficiency. It is obvious that the use

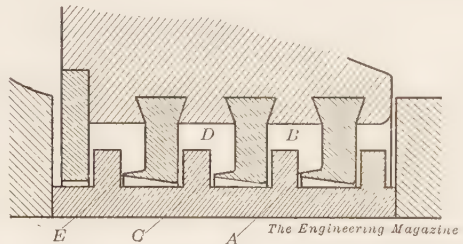


FIG. 19. LABYRINTH BUSHING

of double the number of rotating sheaves for compressing the same quantity of air doubles also the amount of energy lost by frictional resistance. In other words, a blower like that shown in Figure 20 is simply two blowers, each for half the delivery, coupled in parallel; and as the efficiency of all rotating machines drops with decreasing delivery, it is clear that the efficiency of these two blowers must be lower than if the whole quantity were dealt with in one single machine.

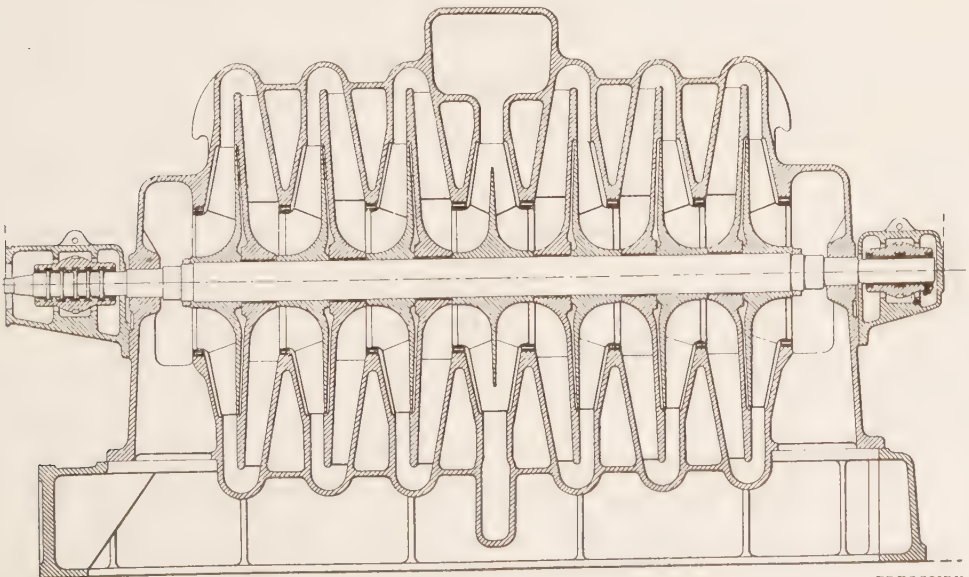


FIG. 20. FURNACE BLOWER DELIVERING 25,000 CU. FT. OF AIR PER MINUTE AGAINST A PRESSURE OF 40 LB. PER SQ. IN.

Supplied to Bolckow, Vaughan & Co., Middlesboro, by Brown, Boveri & Co.

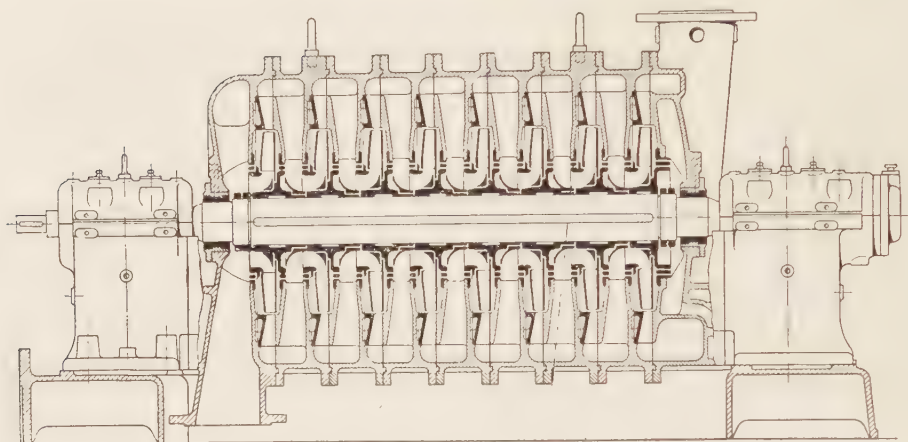


FIG. 21. PISTON-BALANCED TURBINE COMPRESSOR, C. H. JAEGER & CO.

BALANCING BY DIMINISHING BACK AREA

Another design which is standard in the blowers of some of Prof. Rateau's licensees, for example the Skoda-Werke at Pilsen, and Messrs. Kuehnle, Kopp & Kausch, at Frankenthal, is adopted from the well-known Rateau turbine pumps. The excess pressure acting on the back of each impeller can be cancelled by simply diminishing this back area *pro rata* with the increase in pressure. This is done by leaving free an annular margin at the periphery of the back of each impeller as shown by Figure 18. The disadvantage of heavy wear and tear, which appears when this system is used in turbine pumps, is certainly very much less serious when atmospheric air is dealt with. Nevertheless, there is a certain loss due to the formation of vortices in the cells of the impeller where the air is confined by a rotating disc on one side and an immovable casing on the other side, and this defect is unavoidable in this otherwise excellent balancing system.

BALANCING BY BALANCING PISTON

The design which is now practically standard, Figure 21, is characterized by a continuous flow of air

through the impellers in one direction, while the consequent axial thrust is reduced by other means.

Beyond the last stage there is fixed on the shaft a piston which is of the same diameter as the entrance of the impellers and extends as far as possible axially. It revolves with a very small clearance in a box containing a labyrinth, such as that described above.

One side of this piston is under the full pressure of the last stage, the other side being connected by a large pipe to the entrance chamber. The effort which the pressures of all the stages exert on the piston area is thus equal to the effort which the pressures of the single stages altogether exert on the single impellers, and as the two forces act in opposite directions, the balance is perfect. Here, again, is another reason for limiting the number of stages that may be coupled together in a single casing; for, although it is possible, normally, to keep the losses caused by the balancing piston of a blower within limits of 1 per cent, this would not be possible if the pressure differences were as great as 50 pounds or perhaps 100 pounds per square inch.

STUFFING BOXES

The problem of a reliable and tight stuffing box, which is so difficult in the design of turbo-pumps, can be most perfectly and easily solved in a turbo-compressor. The first group of a compressor, or the whole of any blower which is of the piston-balance type just described, needs, we might say, no stuffing box at all, as both free ends of the machine are under atmospheric pressure, and if air should be sucked in around the shafts, no harm would be done, as

air is just what the blower requires; only in cases where the blower has to deal with very poisonous or valuable gases would it be necessary to provide a special packing. In all the following casings (that is, in casings containing the high-pressure groups), stuffing boxes may be wholly dispensed with by using a fully capped bearing, as in Figure 11. The probability of water mixing with the oil would of course forbid this design with any good centrifugal pump or water turbine.

ELECTRICAL ACCIDENTS

By Emmett Campbell Hall

CONSIDERING the extensive use made of electricity both for lighting and power in almost all modern industrial establishments, the general lack of knowledge concerning its dangers, and the not infrequent helplessness and panic which is manifested when someone receives an accidental shock, is somewhat surprising. Most electrical accidents are due to ignorance or carelessness, and not infrequently an ill advised attempt at rescue results in a second accident.

Scarcely less important than a knowledge of how to avoid a shock is information as to what should be done if such an accident does occur, as they sometimes will through unavoidable causes, even when greatest care is exercised. In mines, especially, is there great danger of getting a shock, there being little space, little light, and much dampness, and the fact that the earth is used for a return circuit for the electric current places the miner in the position of

standing upon one terminal of an electric generator; therefore, if he touches only a single point connected to the other terminal of the generator, such as a trolley wire, or a live part of a motor, he is likely to receive a shock which may vary from a severe jolt to a bad burn, or even death.

The human body is an electric conductor, although not so good a one as a wire or a metal rail, and current will flow through the body when it is made part of a circuit. The amount of current which will flow through the body depends upon the voltage or pressure of the current, and upon the completeness of the contact between the body and the circuit. A single-cell battery, giving 1 to 2 volts, can cause a current to flow through the body, but the current is too small to be felt. A shock, though not a violent one, will be received from a 110-volt circuit; currents of greater strength must be carefully guarded against.

If a perfect insulator could be found, a man might stand upon it and place his hand upon a trolley wire through which a 500-volt current was passing, and receive no shock, because the circuit through the body would not be complete, and no current could flow. If a man should stand on damp earth and handle a charged wire with gloves slightly damp from sweat, he would probably receive a severe shock; if he wore no gloves, the shock would knock him down, and possibly kill him. There is no such thing as a perfect insulator, though for practical purposes a number of things may be so considered. The most that can be done is to insulate the body to such a degree that the current which passes through it will be so small that no shock will be felt. In other words, a small percentage of the total force of the current is almost sure to pass through the body, no matter what form of body insulation is used. It is therefore obvious that the amount of current which will get through the insulation increases as the voltage that is handled increases. It is not difficult to guard against shock from a 110-volt current, comparatively little insulation being effective. It is much harder to protect the body from 250 volts, and circuits of 500 volts or more should be carefully approached, no matter what form of insulation is used.

Next to contact with trolley wires, the most likely cause of shock is contact with parts of machines or equipment that are not supposed or intended to carry current, but are accidentally charged with electricity. This charging is caused by the failure of insulation, or by a live wire coming in contact with the equipment. The frame of a motor or cutting machine or the iron casing of an

enclosed switch may become alive and as dangerous as a trolley wire.

The frame of an electric locomotive is usually so completely in contact with the track rail that a man cannot get a shock by standing on the rail and touching the locomotive, even, but this, under one peculiar condition, may not be true. If the rails have been heavily sanded, the locomotive may be almost completely insulated from them, and in that case a shock may be received from the locomotive frame or from the draw-bars of the cars coupled to the locomotive.

It is impossible to tell whether conditions are safe unless the man concerned has made them so himself—no one can tell by looking at a motor, for instance, whether or not the parts that carry current have come in contact with the frame of the machine. Whenever possible, common sense should dictate that the current be cut off before anything is touched that *might possibly* be charged. If it is impossible to cut off the current, or if repairs must be made to live apparatus, the only way to be safe is to provide something suitable to stand on while doing the work. *Dryness* is the most desirable quality in such an article. Perfectly dry boards, free from nails, are good.

Rubber gloves, or leather gloves in good condition and without metallic fastenings, will protect the body from shock. If the rubber covering of gloves is worn thin, the gloves give almost no protection, and the same is true of leather gloves which from any cause are damp. Rubber boots without nails in the soles or heels are good protection when new, but if the soles are worn or cracked, their value is doubtful. Rubber tape on the handles of pliers and other tools cannot be depended on unless the tape has been freshly and care-

fully applied. If a man has to make some adjustment, he should use but one hand, if possible, and he should also try to place his body in such an attitude that the involuntary recoil from a possible shock will remove his hands from the apparatus instead of causing him to grasp it.

When a man has received a shock which renders him senseless, two things should be done as soon as possible: remove the victim from contact with the electric wire, and revive him by getting him to breathe. Great care should be exercised by the rescuer not to get a shock himself. If a switch is at hand, the current should, of course, be cut off, but if there will be any delay in cutting off the current, remove the body from the circuit by means of a piece of dry wood, using it to push the body aside or to life from the body whatever is carrying current to it. Tools with *dry* wooden handles, such as picks or shovels, may be used for this purpose. The body can be safely grasped with the hands, if the hands are protected with several thicknesses of *dry* cloth, or if the rescuer stands upon a piece of *dry* wood. Take hold by the victim's clothing only, if practicable, not of the body where bare. If nothing else can be done, it may be possible to short-circuit the current, and thus blow the circuit breakers or fuses. A short circuit may be made by placing a piece of pipe or other metal article so that it will connect the two sides of the circuit. For instance, if the victim is in contact with a trolley wire, the wire, chain, or what not, should be thrown across the trolley wire and the track rail, so as to be in contact with both. In doing this,

one must, of course, be sure that the pipe or chain leaves his own hand before it touches the current-carrying part of the circuit.

When the victim has been removed from contact with the current, turn him on his back, loosen the clothing about his neck, chest, and abdomen, and place a small log or rolled-up coat in such a way as to throw his head back and his chest up. Next, with a piece of dry cloth, take hold of his tongue and draw it well out. This clears the windpipe, and unless it is done, and the tongue *kept* out, the victim cannot be made to breathe. Next, kneel behind the head of the victim, grasp his forearms just below the elbows, and draw the arms backward until they are extended as far as possible over his head, and hold them there for about one second. Then slowly push the elbows forward and downward to the ground, then press them firmly against the chest and hold them there for about one second. These movements are to be kept up until the patient is revived—usually the victim of an electric shock can be made to breathe within an hour, and the artificial respiration should be continued at least that long, even though the victim shows no sign of reviving. The movements described must be gone through *slowly* and steadily. During this time the victim should be kept as warm as possible, and after he begins to breathe, his limbs should be rubbed briskly, the rubbing being toward the heart. All electric burns should be treated as ordinary burns would be—covering the burnt places with several thicknesses of picric-acid gauze, or, if nothing else is at hand, with vaseline, or olive or linseed oil.



LEGISLATING FOR INEFFICIENCY

JESTERS have made merry with the legislator who proposed to repeal the law of supply and demand. The wisdom of his effort, however, was quite as great as that embodied in Senate Bill 6172, reported favorably from the Committee on Education and Labor by Mr. Borah. By this bill it is forbidden to make any time study between the starting and completion of any job, or to pay any premium or bonus or cash reward, to Government employees.

All progress in science and the arts depends on making measurements and establishing standards. All evolution proceeds by rewards apportioned to efficiency of effort. Not even a Government employee can hope to nullify natural law.

Steam engineering, in its marvelous development, is one long sequence of steps made and guided by measurements. Hygiene and medicine have become exact through collation and comparison of multitudes of painstaking measurements. The victories at Stockholm over which Senator Borah's countrymen are still rejoicing were founded upon years of time studies and man measurements. The enormous gain in American naval efficiency—the added protection to Senator Borah and his constituents summarized by Commander Tardy as a rise from 3 per cent of hits at Santiago to 45 per cents of hits in ordinary battle practice today—was secured almost wholly by reiterated time study and man study, by thus finding the easiest way of doing the best thing.

The triumph of the racer, the safety of the limited, the success of the delicate surgical operation,

the beauty of the most inspiring symphony—all depend upon submission to, even exultation in, the most minute and exacting time studies. Are the occupations of Government employees too noble to be classed with such as these?

While the Senate debates Mr. Borah's measure for legislating inefficiency into industry, the House will have before it the confusing the great principles of business. Attention has been focused upon the clause fastening presumption of guilt upon an accused corporation and putting upon it the burden of proving its innocence. This topsy-turvy overthrow of a basic principle of Anglo-Saxon law needs no discussion here. But it has obscured the examination of an almost equally remarkable proposition—that the line between innocence and crime is crossed when any concern begins to do 30 per cent of the business in its field.

The curious irritation of it is that these neo-economists do not see how they have simply swallowed the "lump of labor" fallacy in a slightly disguised form.

The artificial barrier of a 30 per cent dead line would be of itself a paralyzing restraint of trade. What is needed is not an artificial limiting level at the top of activity, but the restoration of a natural level at the bottom of prices; not an artificial provision of apparent competition, but the restoration of natural competition by the cancellation of special tariff privilege; and with this, abundant light of publicity and sufficient Government control to disclose and punish wrong doing.



REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS
AND TECHNICAL PRESS OF EUROPE AND AMERICA

THE MANUFACTURE OF ATMOSPHERIC NITROGEN

ELECTRO-CHEMICAL PROCESSES FOR THE FIXATION OF NITROGEN

Ernest Kilbourne Scott—Journal of the Royal Society of Arts

THE two main sources of fixed nitrogen are sulphate of ammonia from gas-works, etc., and sodium nitrate from the country of Chili. The production of the former in Great Britain amounted, in 1910, to about 370,000 tons, and the export of the latter from Chili about two and a half million tons per annum.

Against these figures the output of calcium nitrate and calcium cyanamide, which are two of the main products of the electric fixation of nitrogen processes, seem small. The important thing to notice, however, is that electrical processes are now on a sound commercial footing, and very large extensions of plant have been made recently.

Although the first experimental plant was started only nine years ago, already the company controlling the patents of the direct process of Professor Birkeland and Mr. Sam Eyde for the manufacture of calcium nitrate, have installations aggregating 200,000 horsepower at work.

The other electrically-produced nitrogenous manure, calcium cyanamide, is made by a more indirect method invented by Dr. Franck and Dr. Caro.

The Birkeland-Eyde furnace depends on the inter-action of an alternating-current arc in a constant

magnetic field. The furnace, as installed at Notodden, consists of a circular sheet-steel drum about 8 feet in diameter and 2 feet wide, lined with refractory firebrick, and having a disc-like space in the centre, $6\frac{1}{2}$ feet diameter and $1\frac{1}{4}$ inches wide. Air is supplied at the centre of the furnace by a Root's blower, whilst a channel round the periphery of the disc space carries off the gases and oxidised air, as shown in Figure 1.

Two electrodes project into the centre of the furnace, and are approached to within about a third of an inch. Surrounding the points of the electrodes there is a magnetic field of about 4,500 lines of force per square centimetre. Alternating current at 5,000 volts and fifty periods per second is supplied to the electrodes, and direct current flows round the coils to produce the magnetic field.

When an arc is struck between the electrodes, it is at once deflected in a direction perpendicular to the lines of force, and the necessity of having alternating current applied to the electrodes will be appreciated from the fact that with direct current the arc would be deflected to one side only. As each electrode is alternatively positive and negative, the arc is projected outwards first to

one side and then to the other, thus giving a disc of flame about 6 feet in diameter. The speed at which the arc moves outward is extremely rapid, and as the formation of a new arc is practically instantaneous, it appears to the eye as a sheet of flame.

When the extremities of the arc retire along the electrodes, the arc increases in length, its resistance

heat given off by the gases being used to raise steam for concentrating the products and for driving the air compressors for pumping acids, soda, etc. The gases then go through tubes in the evaporating tanks, after which the temperature is down to about 250 degrees Centigrade. The temperature is lowered still further, to 50 degrees Centigrade, by passing it through a number of aluminium tubes over which cold water is flowing. The gas then enters the oxidation tanks, which are large vertical iron cylinders, having acid-proof linings. Here it continues to take up oxygen to form nitrogen peroxide, the percentages being now about 98 per cent air and 2 per cent nitrogen peroxide.

The nitrogen peroxide is brought into contact with water to form nitric acid, in two series of four towers. These towers are built of granite and are filled with broken quartz, this substance and the granite being chosen because they are not affected by acid. Each tower measures 2 metres square by 10 metres high, and it has been found that they will give an absorption of 3.3 kilograms of nitric acid per cubic metre of space per 24 hours.

The liquid trickles down through the quartz, and meeting the nitrogen peroxide gas, combines with it. The liquid moves from tower to tower in the opposite direction to gas. Thus the fresh water enters at top of the fourth tower, it flows down through the interstices between the pieces of quartz and falls into a granite tank. From there it is pumped by compressed air to the top of the third tower, down which it trickles into another tank, thence by pumping to the top of the second tower, and so on. When the liquid reaches the bottom of the first tower it contains about 40 per cent nitric

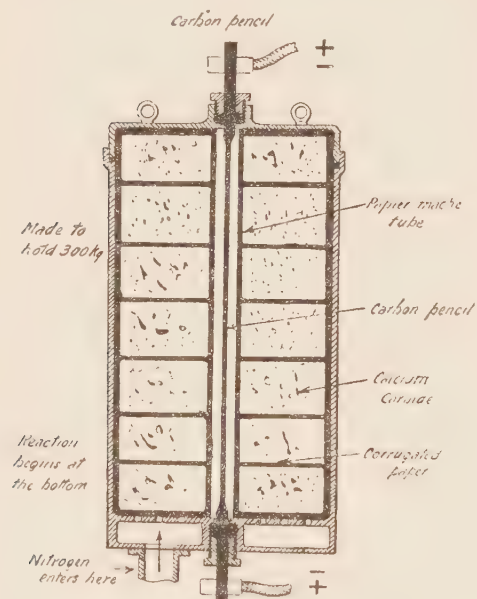


FIG. 1. BIRKELAND-EYDE FURNACE

also increasing, until the tension is such that a new arc strikes between the points of the electrodes. The resistance of this short arc being smaller, the tension of the electrodes suddenly sinks to a point that will not sustain the long arc, which is thus extinguished. Another arc starts, and so the process goes on.

As carried out at Notodden, the method of making calcium nitrate is as follows: The nitric oxide gas and air pass from each furnace into two fireproof-lined gas-collecting pipes, about 6 feet in diameter, lined with fire-brick. These pipes convey the gas to four steam boilers, the

acid. This 40 per cent solution of nitric acid is sprayed over calcium carbonate, the carbon dioxide gas is driven off and calcium nitrate remains.

The solution is then pumped into solidification pans, under which cold air is circulated to accelerate cooling, and the nitrate of lime stiffens into a brittle, crystalline mass. The mass is then granulated, packed in barrels, and is ready for shipment.

With the Birkeland-Eyde process, one kilowatt-year gives 500 to 550 kilograms of nitrate of lime. The latter usually contains 13 per cent of nitrogen, which corresponds to about 115 kilograms of combined nitrogen.

The problem in the fixation of nitrogen is to raise the temperature as quickly as possible above the igniting point of nitrogen and oxygen, and then immediately to cool the fixed gas and draw it off. The temperature of the burning nitrogen and oxygen flame is lower than the igniting point by about 200 degrees Centigrade. There must be a "hot cold zone," that is, a zone wherein the temperature is enormously high in one part and as low as possible in another part. As the electric arc gives in an easy manner the temperatures above ignition-point it is principally used.

The Rjukan installation is situated in Vestfjorddalen, East Telemarken. The saltpetre factories are situated at Saaheim, and the hydro-electric power-plant on the Maane River, half a kilometre away. The annual production will amount to 70,000 tons of nitrate of lime and 8,000 tons of nitrite.

The furnace invented by Mr. H. Pauling, of Gelsenkirchen, Westphalia, was taken from the idea of the well-known horn-break lightning arrester. As installed at Gelsenkirchen and Innsbruck it consists of two hol-

low iron electrodes, arranged to form a vee, which at the lowest point is about 4 centimeters across. At this point there are two lighting knives, which can be approached to within a few millimetres, and are readily adjustable. The arc strikes across and runs up the diverging electrodes by reason of the natural convection currents, and the repelling action of its own magnetic field, but principally because of a blast of heated air from an air-duct immediately below. The arc diverges as it follows the shape of the electrodes, and it attains a length of about a yard. At each half-period of the alternating current a fresh arc forms, so that the result is the equivalent of a triangular sheet of flame.

An important feature is that the wall which divides the two parts of the furnace is hollow, and gas and air which has been through the furnace previously and been cooled, is blown through this central passage. This cool gas and air strikes into the top of the arc flame, and it serves to cool the gases which have just been formed. The two arcs are in series, and the furnaces work in sets of three, one to each phase. Each furnace, therefore, receives single-phase current at 6,000 volts, fifty periods per second.

At Gelsenkirchen there are twenty-four such furnaces, each taking 400 kilowatts at 4,000 volts.

The works of La Nitrogène Cie, at La Roche-de-Rame, Hautes Alpes, France, have nine Pauling horn-arrester furnaces of 600 horse-power each in operation, and nine more of 1,000 horse-power each are being added.

Some idea of the efficiency of the plant may be obtained from the fact that Mr. Pauling guarantees 60 grams of 100 per cent. HNO_3 per kilowatt-hour of electrical energy, measured at the entrance of the elec-

tric transmission line into the factory; and also that the electro-chemical plant proper will cost about 120 francs per kilowatt.

The Southern Electro-Chemical Co. of Nitrolee, South Carolina, in the United States, has a 4,000 horse-power plant on the Pauling system for manufacture of calcium nitrate. Electric energy is generated in two water-power plants at Great Forks and Rocky Creek.

The discovery of calcium cyanamide came about as the result of a research by Dr. Franck and Dr. Caro, who were following on the lines

in which it is ground fine, the whole of these operations being effected automatically in an air-tight plant so as to prevent acetylene gas being given off.

The power is then filled into electric furnaces, of which, in the first installation at Odda, there are 196, each holding 300 kilograms.

Figure 2 is a rough sketch of the furnace, and it will be noticed that down the centre there is a cardboard tube to provide a space for the carbon pencil. After the carbide has been filled in, the carbon pencil is fixed in position and the lid fastened down and made air-tight.

Alternating current is now switched on, and the temperature is raised to 800 to 1000 degrees Centigrade. The cardboard tube and certain cardboard partitions which had been placed in the furnace when the calcium carbide was run in, are burnt up, and they leave spaces which allow the nitrogen gas, which is admitted under pressure, to circulate freely. Electric current is kept on for twenty-five hours, and at the end of thirty-five hours all the nitrogen has been absorbed as shown by the meter.

The 196 furnaces make about thirty tons of calcium cyanamide, containing 18 per cent. of nitrogen, per day of twenty-four hours.

When it is turned out of the furnace the cyanamide looks like black clinker. After being broken up it is fed into jaw crushers, and then goes to roulette mills, where it is ground up fine for market.

Although calcium cyanamide is mostly employed as a manure, it has other uses. For example, by treating with superheated steam very pure sulphate of ammonia is obtained. Also the valuable constituents of modern explosives, ammonium nitrate and dicyandiamide, are made from it.

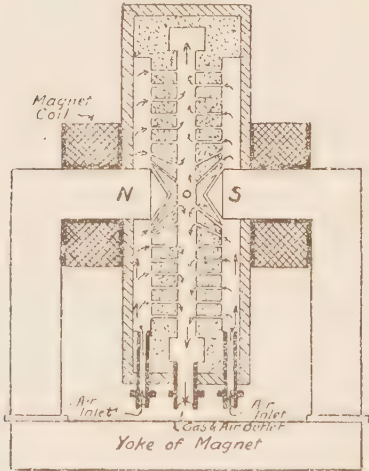


FIG. 2 CALCIUM CYANIMIDE FURNACE

of some previous work of Playfair and Bunsen. Their immediate object was to make cyanide of potassium for the recovery of gold from tailings, and they incidentally found that barium carbide absorbed nitrogen to form barium cyanamide. By using calcium carbide they obtained a similar reaction. It was then found that by treating calcium cyanamide with hot water it gave off ammonia and this gave rise to the idea of using it as a manure.

As carried out at the Odda Works, the calcium carbide broken into lumps is delivered to crushing machines, from which it passes to mills

REFUSE DISPOSAL PROJECTS

AN OUTLINE OF FOUR METHODS FOR DISPOSING THE REFUSE OF CITIES
HAVING A POPULATION OF 600,000

Engineering Record

THE projects submitted for the disposal of refuse for the city of Toronto, Ontario, by Messrs. Rudolph Hering and John H. Gregory, of New York, should be of interest to other cities of similar size that may be planning disposal plants, both as to the methods suggested and comparative operating costs.

It was first thought, in Toronto, that the process of incineration would be the only rational and sanitary mode of destroying the city refuse, but a new and unexpected local factor entered into the problem during 1910 when electric power, generated at Niagara Falls, was introduced in Toronto at a cost substantially lower than that required to convert the heat developed by refuse incineration into electric or any other form of power, which is the chief asset of incinerator plants in other cities. It was this factor which influenced the recommendation of the reduction method for disposing of the city's garbage instead of the incineration method.

Four separate projects were considered, based upon incineration or reduction, with or without utilizing the salable portions of the rubbish under either basis.

The comparison of the four projects is based upon plant capacities sufficient to dispose of the refuse from a population of 600,000, which, it is thought, will be reached in 10 years; Toronto's population by the 1911 census is 376,240. The total weight of garbage, rubbish and ashes collected in Toronto amounts

to about 0.55 ton per capita per year; the relative amounts per capita per year are, garbage 0.1 ton, rubbish 0.05 ton, and ashes 0.4 ton. On this basis the total estimated weight collected from a population of 600,000 would be 60,000 tons of garbage, 30,000 tons of rubbish, and 240,000 tons of ashes per year, a total of 330,000 tons.

In project A it is proposed that all of the garbage and rubbish, together with ashes amounting to 20 per cent of the mixture, be incinerated, the remainder of the ashes to be used for fill. With a population of 600,000 the average daily amounts to be incinerated would be: Garbage, 200 tons; rubbish, 100 tons; ashes, 75 tons; total, 375 tons. Studies of the cost of construction and cost of hauling led to the conclusion that two incinerator plants, each of a daily capacity of 215 tons of mixed refuse, would be sufficient. In project A it was assumed that the garbage and refuse would be collected together and the ashes separately. No boilers or equipment to produce power are considered in this project on account of the cheapness of electric power from Niagara Falls. As there is believed to be no market for clinker at present in Toronto no clinker mills are included in the cost of construction.

The cost of constructing the two incinerators is estimated at \$478,400. The operating expenses, including interest and sinking fund charges, are given as \$124,940 per year for the two units, or at a rate of \$1.11 per ton of refuse handled.

Project B, for two 195-ton incinerators, is similar to project A, except that the garbage and rubbish are to be collected separately and sorted over to recover salable material. Only a portion of the ashes would be delivered at the incinerators, the remainder being used for filling. The estimated average daily weights to be handled in project B are somewhat less than in project A. For 600,000 population there would be 200 tons of garbage, 67 tons of rubbish, and 68 tons of ashes daily, a total of 335 tons. It is assumed that two-thirds of the total rubbish collected would be burned, the other one-third being picked out and sold.

The estimated cost of constructing the two 195-ton incinerators, including means for picking out and handling the salable portions of the rubbish, is estimated at \$489,300, with annual gross operating expenses of \$166,570. In Buffalo, N. Y., the average receipts from the sale of material picked out from the rubbish for a period of over 4 years were \$2.34 per ton of rubbish handled; on the basis of \$2.25 per ton for Toronto the sale of the picked material will yield an income of \$67,300 per year, thus giving a net annual cost of operation of \$99,070, or 89.9 cents per ton of refuse handled. By comparing the operating cost of projects A and B it is seen that the picking out of the salable parts of the rubbish will result in an estimated annual saving of \$25,870.

In project C it is proposed that the garbage, rubbish, and ashes be collected separately; that the garbage be disposed of by the reduction process, (grease and tankage being recovered); that all of the rubbish be incinerated; and that all of the ashes be removed to dumps and used for reclaiming low land. The average daily amounts to be disposed of,

under this project, with a population of 600,000 are: Garbage, 200 tons; rubbish 100 tons; ashes 800 tons; total, 1,100 tons.

The reduction works would have a capacity of 240 tons per 24 hours and would comprise an unloading building, conveyor, digester building, containing digesters and presses for the cooked material, a dryer building where the moisture from the pressed tankage would be driven off, and a percolating building in which grease would be extracted from the dry tankage by means of the naphtha process. The liquids removed from the digester building would go to a grease separating and evaporating building. The syrup resulting from the evaporation of the liquids remaining after the grease had been drawn off would be mixed with the percolated tankage and dried, after which the tankage would be ready for shipment.

The estimated cost of constructing the two 60-ton rubbish incinerators, without means for picking out the salable material, is \$227,700, including land. The operating charges for the two units, based on a population of 600,000, is \$47,180, or at the rate of \$1.573 per ton of rubbish handled.

The garbage reduction works, including loading stations, railroad sidings, power-line, etc., will cost \$538,200 and the gross annual cost of operation, when handling garbage from a population of 600,000, will be \$169,970.

In estimating the receipts from the reduction works at Toronto it is assumed that, with the naphtha process, the amount of grease recovered would be 3.5 per cent and the dry tankage 15 per cent of the weight of the garbage reduced and that grease would bring 3.5 cents per pound and tankage \$7 per ton. On this basis the receipts from the sale

of grease and tankage would be \$210,000 per year, giving a total net income of \$40,030 annually, or 66.6 cents per ton of garbage.

Project D is similar to project C except that the salable parts of the rubbish would be picked out and sold. The garbage, rubbish and ashes would be collected separately. The estimated daily average weights to be dealt with are garbage 200 tons, rubbish 100 tons, ashes 800 tons, the latter to be used entirely for fill. Of the total weight of rubbish only 67 tons would be burned in incinerators each day, the remainder being picked out and sold. Two 40-ton rubbish incinerators and one 240-ton reduction plant are recommended.

The estimated cost of constructing the two 40-ton rubbish incinerators, including means for sorting out and handling the salable part of the rubbish and including land, railroad sidings and paving, is \$255,300. The gross annual operating costs, including fixed charges and the cost of picking over the rubbish is estimated at \$92,510. The receipts from the salable material recovered, based on a value of \$2.25 per ton of rubbish handled, would be \$67,500 yearly, reducing the net cost of operation

to \$25,010 per year, or 83.4 cents per ton of rubbish handled.

The garbage reduction works and accessories are estimated at \$538,200 for construction, and \$169,970 gross for operation, the same as in project C. The estimated annual income from the sale of grease and tankage, however, is \$210,000, leaving a net annual income of \$40,030 for the reduction works.

Combining these estimates for the incinerators and reduction works the total cost for project C is \$793,500 for construction, and with a population of 600,000 it is believed that there will be a net annual income of \$15,020.

After a discussion of the relative merits of the four projects Messrs. Hering and Gregory recommended for the Toronto plant that the refuse be separated into three parts, to be collected separately, that the garbage be taken to a reduction plant, located east of the city and converted into salable products, the rubbish to be taken to incinerators within the city and there burned, either without or with picking. It was also recommended that the ashes be taken to points within the city where land-making or road foundations were desired.

THE EXTRUSION OF METALS

METHODS AND PROCESSES USED WITH THE KRUPP PRESS

Friedrich W. Siepke—Machinery

ALTHOUGH it had been found possible as early as 1850 to extrude such metals as lead and tin and thus form pipes and bars, the extrusion process had not, at that time, been successfully applied to the shaping, by means of extrusion, of such metals as copper, delta-metal, etc. It was when Alexander Dick,

the inventor of the delta-metal, made some experiments with this material under high pressure and at high temperature, during the latter part of the eighties, that it was first shown that this material could be extruded in a heated state.

The advantages of the extrusion process, as compared with the ordi-

nary rolling and drawing process, soon became apparent. The extrusion process permitted parts of unusual cross-section to be produced in great quantities. In fact, sections could be extruded which could not be rolled under any circumstances. On account of the high pressure under which the metal is extruded it becomes more compact and its strength is increased. The extruded shapes, therefore, possess those qualities which make them especially useful in machine design. The surfaces are smooth, and free from flaws and other defects. The dimensions of

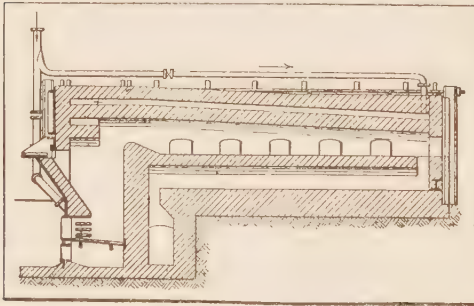


FIG. 1. FURNACE FOR HEATING BLOCKS

the extruded shapes can be gaged with great accuracy, so that they may be used either directly or with very little additional finishing. After the advantages of the new method had become known, it was soon adopted and further developed by many different individuals and concerns.

Instead of pouring the molten metal into the press cylinder, it was found to be better to have it cast into blocks which were heated to a white heat and inserted in the press. In this way the time required for the setting of the metal in the press cylinder was saved, and the efficiency of the machine considerably increased. Further developments resulted in the perfecting of the press, and the metals used for the cylinders and the dies. In order to retain the

heat within the cylinder it was surrounded by a jacket and heated by special means. Several new presses were brought out, and besides the Dick press, those best known in Germany were built by the firm of Friedr. Krupp A. G., Grusonwerk in Magdeburg-Buckau.

The metal blocks are cast in long sections and are afterwards cut up into pieces of suitable size for the presses. The blocks are cast in permanent molds, and in order that as smooth a surface as possible may be obtained, it is necessary that the inside of the mold be of a close-grained metal, free from flaws.

The metal blocks are heated in a special furnace which should be placed close to the extrusion press. The important feature about the heating is that the block must be heated clear through to the center, and not be brought to the press when merely the surface has been brought to the required temperature. A furnace used for heating the blocks is illustrated in Figure 1. The blocks are inserted at the end opposite the grate, and roll by gravity down the somewhat inclined surface toward the fire-box. When the required temperature is obtained, they are pulled out through an opening at the side. The length of the furnace is made to suit the capacity and speed of the action of the press. The width is usually made about three feet. The heated blocks are most conveniently transferred from the furnace to the press by means of an overhead trolley.

The hydraulic extrusion press shown in Figure 2 is of the horizontal type. The press consists mainly of the hydraulic cylinder, the dies, the pressure chamber or extrusion cylinder, and a head which holds the dies. Four heavy connecting bars tie this head to the hydraulic cylinder.

der. The pressure chamber is located between the head and the hydraulic cylinder and moves on four guide bars.

The output of the presses varies according to the size and form of the cross-section of the different extruded shapes. With trained operators and simple cross-sectional shapes,

pressure chamber and jacket an open space is provided through which the heated gases from the fire-place arranged beneath the pressure chamber can pass. By this means the chamber is heated to the required temperature, the gases from the combustion escaping through a pipe above the pressure chamber into the chimney.

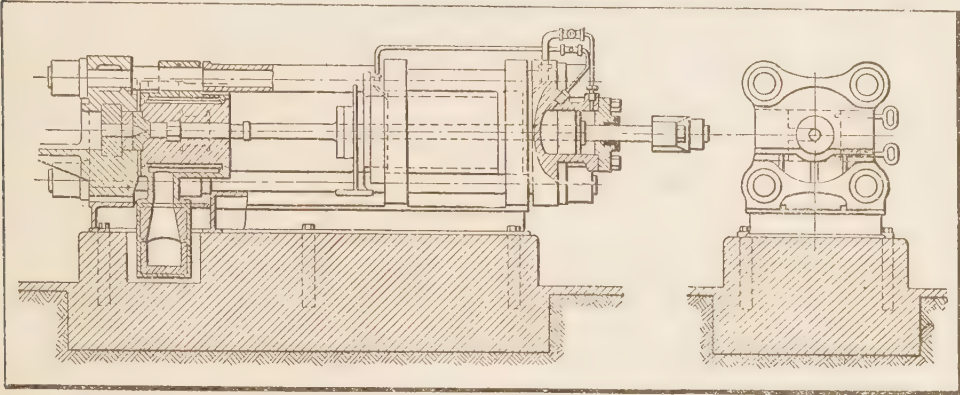


FIG. 2. GENERAL ARRANGEMENT OF KRUPP HYDRAULIC EXTRUSION PRESS

it is possible to extrude about 20,000 pounds of metal in ten hours in the small-size press and 35,000 pounds in the larger press. This output cannot be obtained, however, when tubing of difficult sections is being extruded. The figures given above correspond to two hundred press operations in ten hours. In order to be able to maintain this efficiency the press chamber must be sufficiently heated at the beginning of the work and there must be no interruption in the operation. For the complete installation required for one press, four men are necessary, one of whom works at the furnace.

The hydraulic cylinder is made of steel casting and lined on the inside with a copper bushing. The pressure chamber is made of so-called "Krupp special" steel which even when heated has a high tensional strength. This chamber or cylinder is forged and is provided with a jacket of steel casting. Between the

The required temperature to which the pressure chamber should be heated by external means is about 600 degrees Fahrenheit. This heat is required so that the metal blocks which are heated to some 1650 or 1800 degrees Fahrenheit may not be suddenly cooled. Should sudden cooling take place, the surface of the metal block may lose its plasticity and the extrusion may either be unduly delayed or be made entirely impossible. The high temperature of the walls of the pressure chamber, while the extrusion takes place, requires an especially high quality of metal, and it has been proved in a number of instances that forged Krupp special steel answers the requirements better than any other known material which has yet been produced.

The dies containing the shape for the extruded form are held in the head. This latter takes the pressure during the extrusion process. One

of the greatest difficulties in the past with machines of this type has been to remove the remainder of the metal block in the pressure chamber when operations are suspended or when practically all the metal has been extruded. Part of the metal would usually be pressed in between the joints, solidify and make the removal of the various parts difficult. In the Krupp press this difficulty is taken care of as follows: As already mentioned the pressure chamber is placed between the head and the hydraulic cylinder, but is movable on four guide rods. A tapered hole is provided in the pressure chamber in the end towards the head, and the dies are formed with a corresponding taper. An auxiliary hydraulic cylinder is provided at the right-hand end of the press in Figure 2, and the pressure chamber is connected with the piston of the auxiliary cylinder by means of a cross-head and two connecting-rods. By this means the pressure chamber can be operated. Before the beginning of the extrusion, the pressure chamber

is forced against the die by means of this auxiliary cylinder, and due to the tapered hole and the tapered end of the die a very close-fitting joint is provided, so that the metal, during the extrusion process, cannot enter between the two surfaces. At the end of the extrusion, the auxiliary cylinder operates the pressure chamber in the opposite direction, thus opening up a space between the die and the pressure chamber and making it possible to easily remove the remaining metal from the top of the die.

The press can be operated with considerable rapidity. For simple shapes, it is possible to go through the complete cycle of operations for one metal block in three minutes, this time being divided as follows: Putting the metal block into the pressure chamber, 1 minute 25 seconds; extrusion, 50 seconds; opening up the space between the pressure chamber and die, 10 seconds; removing the remaining metal, 15 seconds; and returning to the original position, 20 seconds.

ALUMINUM TRANSMISSION LINES

BRITISH PRACTICE IN THE USE OF OVERHEAD ALUMINUM CONDUCTORS

Charles L. Johnson—Electrical World

CONTRARY to the generally expressed opinion, the conditions of British overhead transmission lines are as favorable to the substitution of aluminum for copper as in any other country. With the comparatively low transmission pressures employed, a fairly heavy conductor, cheap insulators and short spans with cheap creosoted wooden poles are usual, and consequently the cost of the conductors is a very substantial proportion of the total cost of the line, sometimes

as high as 60 per cent. Thus, considering capital cost only, the use of aluminum for the conductors may result in a saving of some 20 per cent on the total cost of the line, including erection, but excluding rights-of-way.

The chief reasons why aluminum is not already employed in the United Kingdom to a greater extent than it is, are undoubtedly the general greater conservatism of the average British engineer and the fact that much publicity was given to

some very unsatisfactory results obtained by one important concern with aluminum lines erected many years ago, the troubles with which were traced to the use of solid wires of doubtful purity.

An estimate of the saving to be effected in the first cost of aluminum over that of copper for use in transmission lines, can readily be made. A hard-drawn aluminum wire has 61 per cent of the conductivity of a hard-drawn-copper wire of the same size, and, therefore, an aluminum wire or cable must have 1.64 times the sectional area, and consequently 1.28 times the diameter of the equivalent copper wire. As the specific gravity of aluminum wire is only 2.71, as against 8.95 for copper wire, the aluminum cable will weigh one-half the equivalent copper cable.

In the United States the average market price of the two metals has been, aluminum 21 cents per pound, and copper 13 cents per pound. Owing to manufacture the cost of hard-drawn wire may be taken as 27 cents per pound for aluminum and 15 cents per pound for copper. On this basis alone the saving effected by the use of aluminum in the United States would be only 10 per cent less than the cost of copper, and, as it has been found that this saving is largely offset by the increased height and cost of transmission towers, there is little inducement for the American engineer to adopt this metal.

The American, European and Canadian quotations for copper are practically identical and may be taken at present at 12.5 cents per pound. The European and Canadian quotation for aluminum, however, is only 13 cents per pound as against 21 cents in the United States. In these countries, therefore, the prices for hard-drawn wire are approximately 19 cents and 15 cents per pound for aluminum and

copper respectively, with the result that the substitution of aluminum for copper effects a saving of over 36 per cent.

A careful analysis of the figures of costs contained in the official publications of the Ontario Hydro-Electric Commission show that, in the case of the main line to Toronto, consisting of two three-phase circuits each comprising three No. 4-0 B. & S. cables, the six cables cost \$1,450 per mile as compared with \$2,050 per mile for copper cables (copper wire at 16 cents per pound and aluminum at 23.5 cents per pound), showing a saving of nearly 30 per cent on the cables alone. This saving was reduced to 5.6 per cent only on the total cost of the line, partly because the actual towers weighed 1.72 tons as against 1.57 tons for towers for an equivalent copper line, and partly because the cost of the cables was only 30 per cent of the total cost of the line, including erection but excluding rights-of-way.

It was stated that one of the chief reasons for the use of aluminum in preference to copper for the above lines was the lower corona loss with aluminum conductors. At the high pressure employed, namely, 110,000 volts, the section of conductor for copper was so small as to approach the limit at which the corona loss becomes very considerable, and the 28 per cent greater diameter of the equivalent aluminum cable was, therefore, an important advantage. As the corona loss is one of the most important of the difficulties to be overcome in future lines at very high pressures, this advantage of aluminum will necessarily carry great weight. There are at present some thirty transmission lines with aluminum conductors in operation in the United Kingdom. The line at Aldershot was erected for the British War

Office according to the specifications of Messrs. Kennedy & Jenkin, the consulting engineers. This line is of particular interest in so far as it is the first instance within the writer's knowledge of the Board of Trade (the British government authority for the public safety, etc.) permitting a high-tension overhead line on a public road. It is a three-phase line constructed in three lengths of different size and operated at 3,300 volts. It is carried for a total distance of 7.5 miles over natural moorland which is very rough and uneven in parts. Four wires have been erected, one being held in reserve which can readily be switched in by suitable change-over switchgear at both ends of the line in the event of the breakdown of any one conductor. The average height of the poles is 34 feet, and the average span 198 feet. The conductors are spaced 4 feet and 5 feet apart. The wooden poles were creosoted to the British Post Office standard specification and are of the A type. Each member is approximately 7 inches in diameter at the top and 9.5 inches at 5 feet from the bottom. The cross-arms are of rolled channel iron. Use is made of a longitudinal steel earth wire above the conductor and horn-gaps and "kicking" coils for protection against lightning. There is also an elaborate arrangement of cradle wires to catch and earth the high-tension conductors in the event of a break. Use is made of the inverted type of terminal sealing boxes for connecting the line conductors to underground paper-insulated armored cables.

A particularly interesting overhead distribution system is that erected for the Glentawe Electric Supply Company at Ystradgynlais, in Wales. This was erected by the British Insulated & Helsby Cables,

Ltd., and has the distinction of being the first complete overhead distributing network in aluminum to be put up in the United Kingdom. These lines have been at work for about twelve months and the results obtained have been uniformly good. There are some 15 miles of route on this network with conductors ranging from seven 0.159 stranded cable to No. 14 solid wire. The spans range from 90 to 150 feet and the poles from 30 to 36 feet. These lines run along country roads and are operated at 240 volts direct current. It is noteworthy that there are here in use nearly 3 miles of Nos. 14 and 12 hard-drawn aluminum solid wire, this being the first time such small conductors have been used with success. All of the joints on this system were made at insulators and were married and bound, this method being quite suitable for small conductors. These lines have held up through several gales and have withstood a good deal of frost and snow without any measurable increase in sag.

It will be noticed that in each of the lines described wooden poles are used. These poles are well seasoned and thoroughly creosoted before use and such poles have been found to have a life of from twenty to forty years according to the nature of the soil in which they are placed. Steel lattice or tubular poles with longer spans are employed in some instances, but in general the wooden poles with short spans are more economical for the comparatively low-pressure work carried out in the United Kingdom.

Steel poles for transmission lines are not likely to come into common use in the United Kingdom for various reasons: First, rights-of-way are difficult to obtain. This causes the lines to zigzag considerably and

makes short spans inevitable (very few exceed 240 feet) with short spans the wooden poles are sufficiently strong. Secondly, creosoted wooden poles withstand the atmospheric conditions in the United Kingdom

better than steel and are cheaper to maintain; in the United Kingdom steel poles need repainting every third year because of the smoke and damp, while the creosoted poles require little attention.

THE HELE-SHAW HYDRAULIC TRANSMISSION

AN INFINITELY VARIABLE GEAR TO REPLACE THE CLUTCH, GEAR-BOX, AND DIFFERENTIAL IN MOTOR DRIVEN VEHICLES

Engineering

WHILE the transmission of power from electric motors and internal combustion engines by means of hydraulic pumps and motors is by no means a new idea, yet the pump of the Compayne hydraulic transmission system, invented by Dr. Hele-Shaw, appears to be the first really satisfactory variable-stroke pump on the market. This transmitting system has already been adapted to the steering of ships, the training of guns, etc., as well as to the driving of motor cars.

The construction of the pump will be gathered from the diagrams, Figures 1, 2 and 3, below, from which it will be seen that the rotor or cylinder body comprises a series of radial cylinders revolving on a fixed spindle. In the length of this spindle two passages P and Q are formed, communicating with two ports, which alternately communicate to

the cylinders as they are rotated. Mounted in the casing of the pumps is a guide-ring, which can be displaced horizontally to either side of the centre line of the cylinder body by means of the spindle E, and which forms a bearing on its inner circumference for a series of slipper-blocks, which form abutments for the plungers fitted to each of the cylinders. In Figure 1 this guide-ring is shown concentric with the cylinder body, and on this latter being rotated, as indicated by the arrow, there being no relative motion between it and the plungers, no pumping action takes place. If, however, the ring be moved to the position shown in Figure 2—namely, to the left of the centre line—it will be seen that the plungers above the centre line will move outwards in the cylinders, and suction will take place through the passage P, and delivery through the other passage Q. By

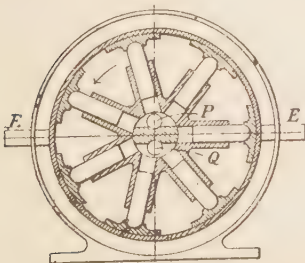


FIG. 1. NEUTRAL POSITION

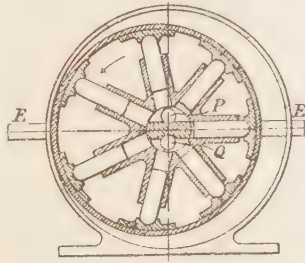


FIG. 2. FULL STROKE AHEAD

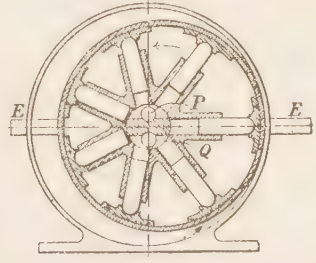


FIG. 3. FULL STROKE REVERSE

moving the guide-ring to the opposite side of the centre line, as shown in Figure 3, it will be seen that the direction of flow of the fluid pumped is reversed, and thus delivery is effected by means of the passage P,

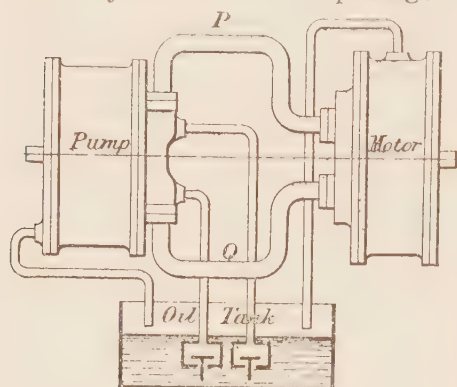


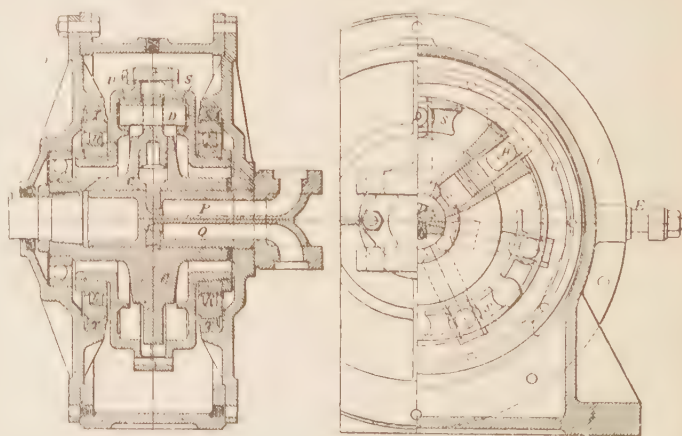
FIG. 4. MOTOR AND PUMP

and suction by the passage Q. It will be readily seen that by giving a partial movement to the guide-ring to either side of the centre, the rate of pumping can be regulated as desired in either direction with a constant speed of rotation. It is further obvious that the reversal of flow can be effected without shock, since in passing the ring from one side of the centre to the other the flow is brought gradually to zero before this change is made.

The motor working in connection with this pump is of similar construction, but is provided with a fixed guide-ring, and consequently has a constant stroke. By connecting the pump and motor in a closed circuit, and by suitably adjusting the position of the guide-ring on the former, a fine gradation of speeds may be obtained on the motor in either direction, the pump being run at a constant speed in one direction. Further, by duly

proportioning the relative displacements of the pump and motor-pistons any desired ratio of "gearing" can be obtained to suit the necessity of the work.

The general design of the pump is shown in Figures 5 and 6. Although the principle of operation follows that already given, an important modification is made in the construction of the guide-ring. The centre spindle, which is made of hardened steel, is fixed in the outer casing of the pump, and is accurately ground to a running fit for the cylinder body which rotates upon it. At the outer end of the spindle two pipe connections are provided, communicating with the two passages P and Q which terminate at the centre line of the pump in two ports. In the pump shown seven cylinders are provided, these being bored radially in the disc-shaped cylinder body C, which, as already mentioned, runs upon the fixed spindle, and is driven by a shaft passing through the side casing, and is further supported by the ball-bearings shown in Figure 5.



FIGS. 5 AND 6. GENERAL DESIGN OF PUMP

The outer edge of the disc is reduced in thickness, and slots are formed in the sides of the cylinders which allow the gudgeon-pins D carried by the pistons to pass through. To each end of the gudgeon-pins are fitted

slipper-blocks S working in the "floating ring" U, which latter forms an essential feature of the design.

Figure 7 shows the application of the Hele-Shaw transmission to the

pump. As soon as the ram has travelled into the position necessary to adjust the main pump to give the desired quantity of oil for the speed corresponding to the position of the

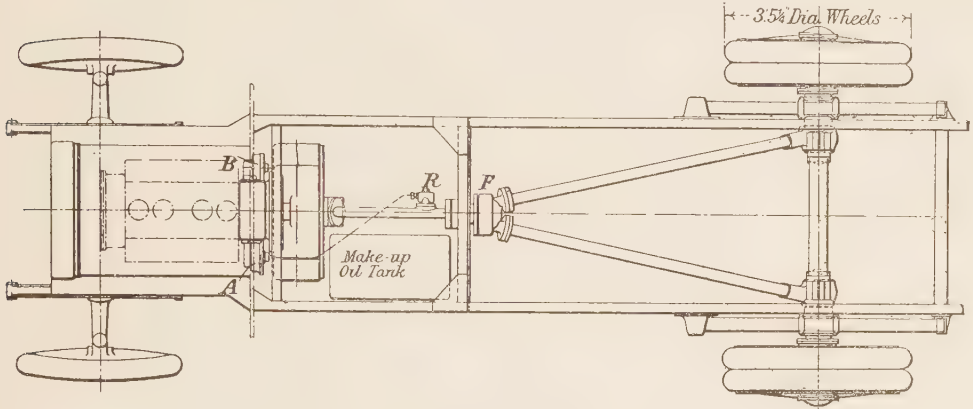


FIG. 7. APPLICATION OF HELE-SHAW TRANSMISSION TO CHASSIS OF MOTOR TRUCK

chassis of a motor vehicle. It will be seen that the pump B is bolted to the engine casing, and is directly driven by the engine without any form of clutch. The oil-pipes from the pump are taken to a universal joint F, rigidly connected to the chassis framing, and in this joint suitable ports are provided for connecting the oil circuit from the pump to two pairs of pipes leading to two motors in the driving wheels. These latter pipes perform the double function of oil-pipes and torque-rods, and since the two motors work in parallel from the pump supply, a perfect differential action is secured.

In connection with the speed control, a second auxiliary pump B, Figure 7, is used. The arrangement of this control gear is shown in detail in Figure 8. The operating pedal is connected to the floating ring of the auxiliary pump by a system of levers, so that, by raising or depressing the pedal, the flow of oil can be regulated as desired. The pipes from this pump are connected to a double-acting ram, which controls the movement of the floating ring on the main

operating pedal, the floating ring of the auxiliary pump is replaced in its neutral position, and remains in that position until a further operation of the pedal occurs.

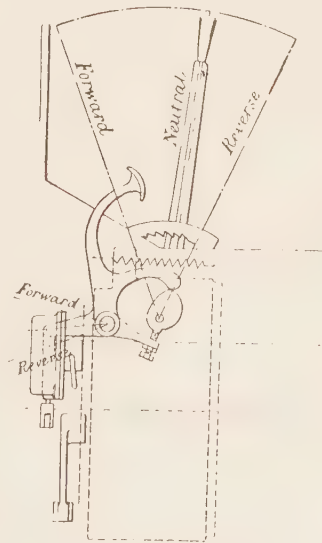


FIG. 8. CONTROL GEAR

In this drawing the lever and its cam are shown in the neutral position, and consequently the pedal cannot be moved; by putting the lever forward the pedal is raised by means

of the spring shown, the amount of this rise owing to the formation of the cam, being greater as the lever is moved forward. This operation of the pedal causes the main pump to deliver oil to the motor and drive it in the forward direction. On again depressing the pedal it comes to rest at the neutral position, whatever the forward position of the lever, owing to the set-screw on the lower arm coming in contact with the cam. By bringing the lever backwards to the reverse position the car can be manœuvred in either direction by raising or lowering the pedal, a portion of the cam being cut away as shown to allow clearance for the set-screw referred to above, and thus permit the pedal to be depressed into the reverse position.

In actual operation the transmission is extremely flexible, and on account of the gradual reversal of the oil-flow it is possible to change over from full speed in the forward direction to the reverse direction

without shock. The action of reversing naturally acts as a brake, and although an emergency brake is fitted, the whole control of the car can be effected by the single pedal controlling the action of the pump. On the dashboard of the car two pressure-gauges are mounted, which indicate to the driver the conditions of working, and in common with other applications of the gear, relief-valves are fitted, which relieve the pressure at any desired pressure.

From this description of the pump it will be seen that all the working parts are of circular shape, and thus offer no difficulty in their accurate manufacture, since they can easily be ground to the desired limits. A number of these pumps have been put to extended use, and it has been found that on account of the efficient lubrication wear is practically nonexistent, and the rotating parts being in nearly perfect balance, vibration does not occur even at high speeds.

SUBMARINE SIGNALING

SENDING, RECEIVING AND DETERMINING THE DIRECTION OF SIGNALS

H. J. W. Fay—American Institute of Electrical Engineers

THE fact upon which submarine signaling is based is that water is an excellent conductor of sound. Submarine signaling, as the name denotes, is the art of transmitting sound through water. In telegraphy and telephony wires are used as a medium to transmit energy from one point to another. In wireless signaling we understand the ether is the medium by means of which energy is transmitted. In submarine signaling the medium for the transmission of energy from one point to another is water.

In May, 1898, the late Arthur J. Mundy, of Boston, took up the development of the system of submarine signaling and finally carried it to that point of perfection where it could be adapted to commercial use. After three years of experimental work, in company with Professor Elisha Gray, his development of the system had reached the following condition:

A bell struck under water was heard a considerable distance through a submerged telephone transmitter. The submerged transmitter was lowered over the ship's

side in a calm sea, the ship being motionless and noiseless. Both the sound producing and sound receiving apparatus were complicated and clumsy and not adapted for commercial use.

There was no apparatus which could be installed within the ship and heard a sufficient distance, and no receiver which would not be rendered useless by the noises of a moving ship. No means of determining the direction of the source of sound had been discovered.

The solution, discovered later by Mr. Mundy, lay in the use of an all-water system of submarine signaling and consisted of a microphone in a tank of water one side of which was formed by the skin of the ship below the water line. The water on both sides of the skin forms a practically continuous path from the bell to the microphone.

The discovery made it possible to hear the signals on a vessel moving at full speed in any sea without being confused by the other or foreign noises. It is the only method which removes the foreign noises and at the same time preserves the strength of the signal.

It only remained to design microphones adapted for use in the tank and to develop a method of finding the direction of the bell. The latter was accomplished by means of two tanks one on each side of the ship near the bow, and was patented by Messrs. Mundy and Millet.

At the same time that the receiving apparatus was being developed, good progress was being made in perfecting the sending apparatus so that it would be adaptable to commercial service on lightships, bell buoys and electric cable shore stations.

The very first sound producers tried were 120-lb. bells of the com-

mon locomotive type with a rate of 320 vibrations per second.

These were electrically excited first with pulsating current and later with alternating current. Then larger bells of 300 pounds were tried with a rate of about 400 vibrations per second. Some of these were made of bell metal and some were made of steel and were excited electromagnetically with an alternating current.

With these bells numerous tests were made with the U. S. lighthouse tender *Mayflower* on *Boston Light-Vessel*, and the sounds were heard at varying distances of from one to three miles.

The percussive means of exciting bells was then tried. Numerous experiments were made to determine the weight and shape of the striking hammer. The weight, shape and period of the bell were also undergoing changes as the experiments progressed. A series of tests and experiments finally developed a bell weighing 220 pounds with a period of 1,215 vibrations in water. This type is now being used universally and is adaptable for use on lightships, electric shore stations, and bell buoys.

The first boat on which submarine signal receivers were installed was the *U. S. R. C. Seminole*. Tests were made with this ship in Boston Harbor but the boat was not under way. The bell was operated one-half mile away and was an 800-pound church bell with a rate of about 450 vibrations per second.

The next vessel to be equipped was the *Cape Ann*. This was the first boat on which tests were made with the vessel under way. The signal station used in these tests was an electrically operated bell at Egg Rock. With the *Cape Ann* at half speed this bell was heard at a dis-

tance of three-quarters of a mile.

Later experiments were conducted on the *James S. Whitney*. Wooden tanks were constructed in her fore-peak, using the outer skin of the vessel for one side of the tank. They were very large, containing about 64 cubic feet of water. By the time this ship was equipped with receiving apparatus, *Boston Light-Vessel* had been fitted with a steam struck bell. This bell was an improvement on the former bells, although it was not so large. It weighed about 120 pounds and had a period of 850 vibrations.

Boston Light-Vessel bell was heard by the *James S. Whitney* at a distance of from ten to fifteen miles with the vessel steaming at fifteen knots and actual direction was obtained. This demonstrated the merits of the system.

The next development was to construct tanks which could be readily placed on any ship and give good results. After much experimental work the tank finally adopted was 16 inches square and 18 inches deep with a rubber gasket to make it watertight and to give it acoustic insulation from foreign noises in the vessel.

In equipping a vessel with submarine signal apparatus the most important factor to be determined is the proper location of the receiving tanks on the vessel.

The first consideration is that the tanks shall be placed on the inside of the skin of the vessel in such position as to give them the greatest forward projection, so that the bell may be heard as far as possible when the vessel is heading directly for the signal station.

The second point of importance is to locate the receiving tanks as far as possible below the surface of the water. This condition, however, should not be allowed to interfere

with the forward presentation.

The submarine bell on a light-ship or signal station is submerged and operated at a depth of not less than twenty feet under water. When struck its vibrations are sent out with equal intensity in all directions.

Of the sending apparatus there are four types at present in use; 1, pneumatic; 2, electric; 3, automatic; 4, hand.

For light-ships the pneumatic bell has been the most convenient form owing to the fact that many light-ships carry a store of compressed air.

For lighthouses and other places where a warning signal is desired and where there is no light-vessel and it is necessary to place the submarine bell at a distance from the shore, an electric bell has generally been used.

At places too far removed from shore to permit running a cable, and where there is no light-ship, the bell buoy mechanism is the only one that can be used. So sensitive is it that even in an apparent calm it rings the bell several times a minute.

For places where neither compressed air nor electricity is to be had, a hand bell can be used. In this, a spring is compressed and strikes a uniform blow.

The receiving apparatus is made up as follows:

Two cast iron tanks are placed inside the ship against the skin, one on each bow. They are well below the water line and their distance from the stem varies from 20 to 150 feet, according to the size and shape of the ship. They are filled with salt water and in each a microphone is suspended. Each microphone is connected with the pilot house or chart room by an electric telephone system. The bell sound coming through the water passes through the skin of the

ship, enters the water in the tank and is picked up by the microphone which in turn transmits it to the pilot house. By means of an indicator box containing switches and arranged with two telephone receivers the observer can listen alternately to the sound picked up by the port and starboard microphones. In practise two sets of microphones are used on each ship, one called the "A" set and the other the "B" set, one set being duplicate to the other.

In testing to pick up the bell, the ship is swung to port or starboard. If the bell sound is louder when semaphore reads "Port" the bell is on the port side; if louder when the semaphore reads "Starboard" the bell is on the starboard side. To obtain the exact bearing the ship is swung towards the bell until the sound is equal on both sides. The bell will then be dead ahead.

There are at the present time a

total number of 52 bells operating in United States waters. Canada also adopted the system and has increased the number of bells along her coast until today there are a total number of thirteen.

The French Government and the German Government equipped their light-vessels with submarine bells and later Trinity House, the English Lighthouse Board, adopted the system on November 1, 1906, after exhaustive tests.

As the number of signal stations were increased the number of vessels equipped with apparatus to receive these signals has also steadily increased; among them being the great transatlantic vessels belonging to the White Star, Cunard, North German Lloyd, Hamburg American and Allan lines. There is a total of about 900 vessels equipped with submarine senders and receivers at the present time.

A ROPE-DRIVEN COAL CUTTER

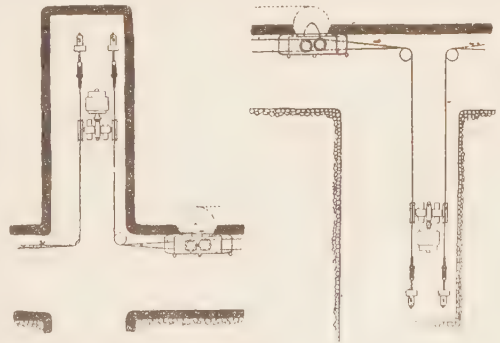
MORE APPROPRIATE IN ITS GENERAL WORKING THAN ELECTRIC SYSTEMS

Wilfrid L. Spence—The Mechanical Engineer

TO the electrician the idea of a wire-rope driven coal-cutter must at first seem to involve a retrograde step. But with changing conditions one is justified in reviewing past methods, in order to find out whether present methods are really incapable of improvement.

Premising that the machine to be described is driven by an endless rope, the proposed general arrangement is shown in Figure 1 for a thick seam and in Figure 2 for a thin seam. It will be noted that provision is suggested for working two machines from one rope-driving gear. Normally both machines will work in synchronism, that is, up on one shaft

and down on the next, for which purpose the reversal of the motor alone



FIGS. 1 AND 2. GENERAL ARRANGEMENT OF MACHINE IN THICK AND THIN SEAMS

reverses the direction of the rope travel. But if one machine be so

delayed that a turn is lost, it is only necessary to remove one rope from the driving gear and put it back the opposite way, so that the machines work one up and the other down on the same shift. The driving gear is specially arranged so as to expedite this reversal.

The motor proposed would be from 40 to 50 horse-power, depending on the subject, and would run at a speed of about 480 revolutions per minute.

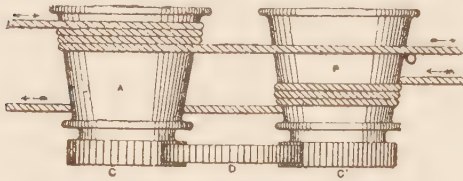


FIG. 3. PRINCIPLES OF DRIVE AND FEED

The gear is of the worm and wheel type, allowing a reduction to $42\frac{1}{2}$ revolutions per minute on the 3-foot rope pulleys, which would give a rope-speed of $4\frac{1}{2}$ miles per hour. The worm has four threads and a thread-angle of 27 degrees, insuring an efficiency of over 93 per cent, with absolute silence in operation. This form of gear lends itself better than any arrangement of spur gear to the installation of the machine in a narrow place.

With reference to the machine itself, the principle of the drive and feed is shown in Figure 3. There are two rope pulleys, A and B, sleeved on vertical fixed spindles; each carries a 4-inch pitch, 13-tooth spur pinion, C, which meshes with the teeth of the cutter wheel, D. The two pulleys must, therefore, at all times run at equal speeds of revolution. The rope is endless, and all parts consequently run at the same linear speed. Actually the pulleys are double conical, so as to insure that the rope, irrespective of the direction of travel, may always run on at a large diameter and off at a

smaller. Incidentally, the cutter wheel can always be run without any feed, but there can never be any feed unless the cutter wheel is running.

Complete controlling gear is provided at both ends of the machine, first to throw the main clutches in and out, and secondly to regulate the feed by altering the relative positions of the ropes on the two pulleys; but the interlocking arrangements are such that, whether travelling to right or to left, the leading end alone gives full control.

The fixed pulley spindle is cast with and suspended from the cover plate, so that the power-transmission mechanism, comprising the spindle, bearing bush, pinion and sleeve, oil bath, pulley, and clutch, is detachable as a single complete unit. The cast steel spindle measures 4 inches at its least diameter, and the other parts are in proportion. The pinion-sleeve forms an absolutely oil-tight bath, which holds more than $1\frac{1}{2}$ gallons of oil. Both the pinion-sleeve and pulley-sleeve bearings run on a level pavement fully immersed in oil.

The clutch is a 70-tooth wheel, every tooth of which engages as a dog, so that little time is occupied in putting it in; and as the engaging surfaces are more than generous, it should come out under a load almost as easily as it goes in. The sliding member, the internally and externally-toothed annulus, remains permanently in engagement with the pinion sleeve. The two clutches are operated together by an equalising lever, and the greater part of the dead weight of both is spring suspended, so as to reduce the wear on the collars and the effort in raising the sleeves.

The wheel of the cutter-disc is machined all over, and split and bolted together with a tongued and grooved joint by right and left-hand screws.

Two sets of slots are provided, one for each direction of cut, and each gives some little cutting angle to the picks. The idle slots are fitted with short dummy picks, so as to maintain solidity all round the wheel. All the picks, both working and dummy, are rolled with a very shallow channel down the front or back faces for location in the wheel slots. There is a chisel edge, pick point, or wedge surface to deal directly with every particle of stuff in the holing.

The slots for the picks are milled out and ended by drilled holes to exactly the same radial distance from the centre. One side of each pick slot is designed so as to be more or less flexible, while the other side is designed to furnish a solid unyielding abutment. Beyond the flexible side the tightening screw is placed in a radially-drilled hole, with the sides cut through to allow for expansion. On tightening up the screw, the taper head forces the flexible side hard up against the pick and that against the unyielding side, so that it is held securely by friction along its whole length. The inner end of each pick is drilled and tapped, and provided with a long set-screw, so that, whether new or whether nearly all ground away, the overall length of the pick and screw projection together is maintained at a constant value. This setting is not to be attempted underground, but should be done to a gauge at the surface, after grinding. The picks are sharpened by grinding only, and require no forging. In form they may be pick-pointed or chisel-edged, and right-hand, left-hand, or central in any combination; but while the central portion of the chisel-edge may not project more than $\frac{3}{8}$ -inch beyond the end of the tooth carrying it, the side portions, right or left, may project another inch.

The general appearance of the coal-cutter is shown in Figure 4. Attention is particularly called to the absolutely clean level top and waste side, and to the free channel beneath for any dross carried through by the wheel. Notwithstanding this large opening, the skid surfaces are abnormally large, being over 5 square feet at each end.

The following are the leading particulars of the machine as constructed at present.

Overall length, $9\frac{1}{2}$ feet; overall width, $2\frac{3}{4}$ feet; overall height, $1\frac{1}{4}$ feet; diameter of wheel over cutters,

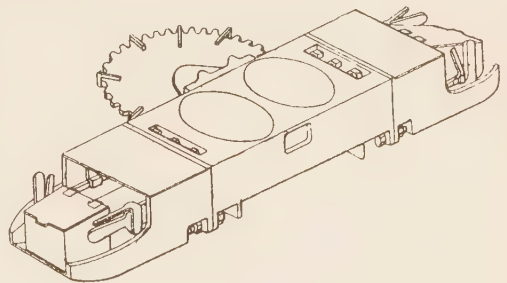


FIG. 4. APPEARANCE OF COAL-CUTTER

5 feet; holing depth, $3\frac{3}{4}$ feet; holing height, $2\frac{3}{4}$ inches; rope diameter, $\frac{5}{8}$ inch; speed, $4\frac{1}{2}$ miles per hour; rope pulley speed, 83 revolutions per minute; cutter wheel speed, 25 revolutions per minute; total weight, 30 to 35 hundred-weight.

For the rope-driven machine it is claimed:

(1) That it is simple. In addition to the cutting wheel, there are only two pinions, two rope pulleys, and two clutches as the essentials. There are no running shafts and no horizontal bearings; there are no keys or keyways, and there is no feed gear apart from the main drive.

(2) That it is very accessible. All the gearing subject to wear is removable in two single units, and any wear is made good by simply relining with white metal.

(3) That it is easily maintained. The picks are renewed by grinding only, without smith-work, and oiling once or twice a week should be adequate for the machine itself.

(4) That it is a particularly safe machine. The silent operation will tend greatly to the avoidance of dangerous falls. The running ropes are guarded, so that frayed wires in an old rope will not endanger the workers. The machine is completely controlled from the front end. The machine cannot run down on a steeply-inclined working. It is incapable of

causing explosion or shock.

(5) That the dimensions make it of almost universal application; it will go anywhere, and on account of the possibility of applying almost unlimited power, it should cut anything met with in a coal mine.

(6) That it is economical. There are no supplies, no brushes, no slip rings, no switch contacts, no fuses, and no trailing cables to renew. But little oil is required, and the perfection of lubrication almost entirely eliminates wear from the main transmission system.

THE SEMI-BRIDGE DUPLEX SYSTEM

APPLICATION OF THE SYSTEM ON SUBMARINE CABLES IN JAPAN

J. Kajiura—The Electrician

THE double-block bridge duplex method of Dr. Alex. Muirhead has been most commonly used as the best in duplexing long submarine cables. It is well-known that in that method such a number of artificial cable boxes as represent the whole, or nearly the whole, length of the main cable must be provided to obtain a perfect balance. If any practicable device which could substitute or decrease the number of boxes required in the ordinary duplex system and give an equally perfect balance were devised, the expense in setting up the system would be greatly reduced.

After a continuous research in pursuit of such a plan as mentioned above, the writer invented a method by which a perfect balance can be obtained more readily by using an artificial cable of only half the length of the cable, and for this invention patents have been obtained in Japan, Great Britain, Germany, France and the United States of America, under the name of the "Semi-Bridge Du-

plex System." On several long submarine cables belonging to the Imperial Japanese Government this new system has given very good results.

The "Semi-Bridge Duplex" is illustrated diagrammatically in Figure 1, in which the duplex arrangement at the distant end of the cable circuit is much abbreviated for the sake of simplicity.

When a sending battery is applied to one of the block condensers, which are interposed at both ends of the line cable, the cable throughout the whole length will ultimately attain a certain potential which is determined by the voltage used, the capacities of the cable itself and the block condensers.

The ultimate potential is by no means established at once; on the contrary, not only is there always a lapse of time before a cable attains the ultimate potential, but the relation of time and the rise or fall of potential is different according to the positions of the cable. At the two

ends of a cable circuit a certain time passes before the ultimate potential is attained, while there is always a certain intermediate position where the required duration of time is much shorter, and the relation of time and the rise or fall of potential can easily be imitated by a suitable simple means without resorting to artificial cables.

It will thus be seen that, if only such artificial cables as correspond to that portion of the line cable lying between one end and the intermediate position be used, and a suitable means, which can imitate the relation of time and the rise or fall of potential at the intermediate position of the cable, be provided at the end of the artificial cables, an exact duplex balance can be obtained, there being no need for using so much artificial cable as to correspond to the whole, or nearly the whole, length of the line cable, such as is used in ordinary duplex systems.

This invention is based on the principle explained above. In the accompanying diagram the artificial cables N from O to P correspond to that portion of the line cable lying between its left end and the intermediate position, and the resistances of the parts of the circuit KLSM, branching from the centre of the balancing rheostat C, are so adjusted that the potential of I' is equal to the ultimate potential of the line cable; and in order to make the relation of time and the rise or fall of potential of I', so connected to the artificial cable, equal to that of the intermediate position of the line cable, an adjustable self-inductance S and capacities B' and C', with or without retardation resistances, are introduced into the circuit, and in some cases a simple resistance, or a resistance having more or less self-

inductance, is inserted between P and I'.

In the accompanying diagram are shown two capacities, B', C', and two resistances, K, L; but generally one capacity and one resistance suffices for the purpose explained, although there are some cases where it is found better or convenient to use capacities and resistances that are more subdivided, or to use some artificial cables instead of capacities and resistances.

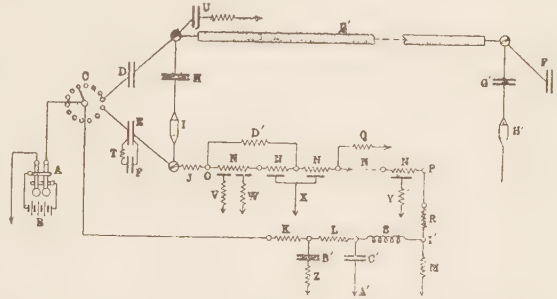


FIG. 1. ARRANGEMENT OF SEMI-BRIDGE SYSTEM

A, key to automatic transmitter; B, battery; C, balancing rheostat; D and E, block condensers; F, slide condenser; H, receiving condenser; I, receiving instrument; J, K, L and M, resistances; N, artificial cable, of which O and P are the beginning and the end respectively; Q, leak resistance; R, resistance containing or not containing self-inductance; S, adjustable self-inductance; T, U, V, W, X, Y, Z, and A', retardation resistances, of which X and A' are instances of no resistance, B' and C' adjustable capacitors; D', shunt of artificial cables; E', line cable; F', G' and H', block condenser, receiving condenser and receiving instrument respectively at the distant end of the cable circuit.

Attention is called to the self-inductance, the use of which as an accessory in the imitating circuit characterises this system. If the self-inductance with iron core is used there will be produced some slight jerk on sending quick reversal currents at the home station. The jerk is due to the residual magnetism of the iron core, which varies the self-inductance at the instant of current reversal. This phenomenon can be removed by the use of a smaller inductance, yet, as it is then necessary to make the resistance and capacity in the supplementary circuit correspondingly smaller at the same time, the amplitude of the signal waves at

the receiving station may be found too small, so as it becomes necessary to have the sending voltage increased to enhance the amplitude. But with ironless inductance, on the contrary, this slight want of balance will not be apparent, and a perfect balance can be obtained.

With the increase of cable length, the inductance and its subjoined con-

sides of the receiving instrument of the home station when that station sends signals, while the instrument faithfully responds to the signals sent from the distant station. With the ordinary duplex system it is sometimes found difficult, or very tedious, to get an exact duplex balance, but with the semi-bridge duplex it is much easier, and thereby the working capacity of cable circuits is increased. Moreover, the semi-bridge duplex requires only about one-half of the artificial cables used in ordinary duplex systems, thereby saving much expense and space.

In 1909 the newly invented system was applied to a cable of 672 miles which had been laid between Sasebo and Dairen; and in 1910 to another cable of the same length between Nagasaki and Formosa for duplex working, and a very satisfactory result was obtained from both of these systems.

Only 320 nautical miles of artificial cable are being used on each of these two cables. Figure 2 shows the arrangement in a balanced state of the system at the Nagasaki station.

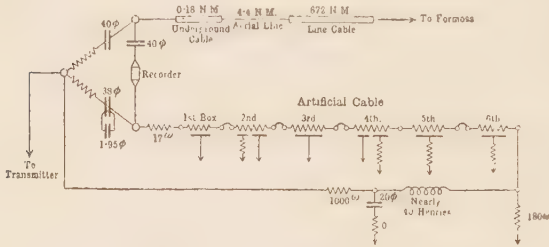


FIG. 2. ARRANGEMENT OF NAGASAKI STATION

denser must be increased and the resistance M decreased generally.

When proper adjustments are made on different parts of the semi-bridge duplex, the relation of time and the rise or fall of potential caused by the sending battery at the home station will be exactly similar in both the cable lying between its end and the intermediate position and the artificial cable; so there cannot exist any P.D. between the two

SMOKE EMISSION FROM FACTORY CHIMNEYS

DISCUSSION BEFORE THE SMOKE ABATEMENT CONGRESS ON ESTABLISHING A SMOKE STANDARD AND SUGGESTIONS FOR EFFICIENT MEASUREMENT

Dr. John S Owens—The Canadian Engineer

IT is probably not open to contradiction to say that the emission of dense smoke from furnaces consuming bituminous coal is unnecessary and indicative of waste of fuel and bad furnace construction or working. It is true that there are a few special cases, such as heating brewery vats and pottery kilns, where the emission of dense smoke

for short periods is by some still considered essential, but it is open to question if this opinion is justifiable. At the same time, it should be remembered that the total absence of all smoke is in practice usually impossible of attainment when the economy of manufacturing processes requires the burning of bituminous coal.

The Public Health Act of 1875, of the laws of Great Britain, supplies the present standard by which smoke is judged throughout the country, except in the case of a few important cities possessing special powers on the subject. In this Act it is stated that "Any chimney not being the chimney of a private dwelling-house sending forth black smoke in such quantity as to be a nuisance shall be deemed to be a nuisance liable to be dealt with summarily under the Act."

The standard "black smoke in such quantity as to be a nuisance" takes cognizance of two separate things in relation to smoke; its quality—that is, it must be black, and its amount—that is, enough to cause a nuisance; but, while these two essentials are taken into account, it is done in such a way that it would be practically impossible to prove in any particular case, either that the smoke was black, or that it was in sufficient quantities to be a nuisance.

At first sight it would seem that the total quantity of soot emitted by any chimney would be the soundest thing to limit, since it determines the amount of pollution of the air by soot from a particular source; but on closer examination it appears that this is not really the best basis. What we are concerned with is the total pollution of the air by soot due to all chimneys in any particular neighborhood. For example, the erection of an electric generating station where large quantities of fuel are burned may, by displacing many small consumers who had previously to generate their own power, actually cause a great reduction in the amount of soot poured into the air. At the same time the total quantity of soot emitted from such a station might be many times greater than that previously emitted by any one of the

smaller power units which it displaced; in spite of the fact that the combustion might be better and the amount of soot per ton of fuel burned much less.

It is suggested, therefore, that the word "black" in the present standard should be altered to "smoke of a density exceeding" some fixed standard. The standard, however, should include also a time of emission, and the form suggested is "smoke which exceeds a certain density (as measured in a way to be determined), and which is emitted for a period exceeding so many minutes per hour."

It is necessary next to consider the question of how the smoke is to be measured, since this is an essential part of the problem of establishing a sound standard.

We may set ourselves to measure any one of the following:—

1. Total quantity of soot emitted in a given time.
2. Weight of soot emitted as percentage of fuel burnt.
3. Density of smoke or weight of soot per unit volume of flue gases.
4. Ratio of density to a standard.
5. Color.
6. Opacity, or degree of blackness.

Of these six possible quantities to be measured, the only one practical to consider is that wherein the ratio of density is compared to some standard.

A quantitative measure of the density of the smoke might be obtained by the filtration method, in which the soot from a known volume of smoke is trapped and weighed, but it would be too cumbersome for general use. Density can also be measured optically, in which cases access to the chimney or factory would be unnecessary. It would give a fair measure of efficiency of the plant, and a good basis of com-

parison whatever the quantity of fuel burnt or diameter of the chimney.

For example, we may compare the degree of opacity of the smoke with a smoked glass which obstructs as much light as a smoke column of known density and thickness. Suppose, then, we take such a glass of an opacity equal to that of a column of smoke of unit thickness and standard density, we might prepare an instrument having several shades of such glass, the lightest being the standard for the smaller chimney, followed by other shades made by superimposing various thicknesses of shade 1, corresponding to various thicknesses of smoke column or chimney-diameter. We could then, by comparing the smoke at the top of a chimney with such a set, say whether or to what extent the standard was being exceeded.

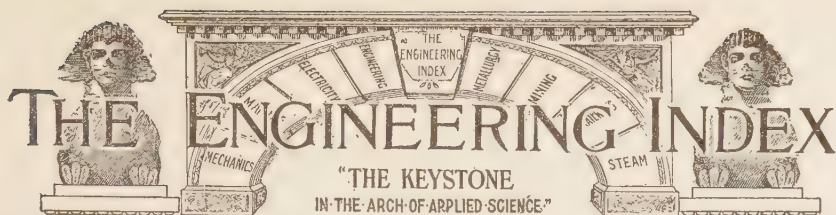
It would be necessary then to provide an instrument to enable a comparison with such a standard to be easily made. One which the writer has designed to meet the requirements laid down in this paper is in the form of a small telescope, having fixed in the optical system at a point which may be brought into the focus of both object-glass and eyepiece, a revolving eccentric disc containing a number of graduated smoked glasses arranged in cells round the centre. The glasses only fill half of each cell so that by revolving the disc, as each cell with its glass is brought successively into the axis of the telescope, the smoke may be viewed through the open half of the cell and matched to the glass in the other half. The glasses are numbered in the ratio of their thickness, and a table is provided giving the number of the glass divided by the diameter of the chimney, and thus a figure which is a measure of the density of the smoke, and can be

made to read the actual weight per cubic foot of soot in the smoke if desired. This necessitates the inspector knowing the chimney diameters in his district; but these may be tabulated once for all.

There are many difficulties remaining which apply to all optical methods of measuring smoke, but we have no other means of attaining our object, since all methods requiring access to a factory or a chimney are useless.

Assuming, then, that we have decided on the method of measurement to be adopted, and on the type of standard to be fixed, the question remains, how is the standard to be arrived at? It would seem that this might be done best by the appointment of a technical committee, which would make observations over a certain period, say a year, of certain selected representative chimneys, where up-to-date and well-designed furnaces are installed, and bituminous coal is burnt. A consideration of the results of such observations, both as to smoke density and time of emission, should enable the committee to fix a fair and reasonable standard, both as to the density of the smoke, and the time during which such density should be permitted.

The fact that a legal, if unsatisfactory, standard has existed for thirty-six years proves that a standard is necessary, and that, to be of use, it must be legally enforceable. The present standard of "black smoke in such quantity as to be a nuisance" has utterly broken down, owing to the impossibility of proving to a magistrate's satisfaction that the smoke emitted was literally black. The writer has tried to show that it is now possible to fix a sound and workable standard for smoke emission, and to apply it in a practicable way.



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

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|--|--------------------------|
| (1) The title of the article, | (4) Its length in words, |
| (2) The name of its author, | (5) Where published, |
| (3) A descriptive abstract, | (6) When published, |
| (7) <i>We supply the article itself, if desired.</i> | |

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the “Explanatory Note” at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes’ time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one’s special interest.

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CIVIL ENGINEERING

BRIDGES

Arches

Notes on the Practical Calculation of the Network of Arches with Pressure Removed (Appunti intorno al calcolo pratico dei Ponti reticolari ad arco a spinta eliminata). Cesare Chiodi. Points on the calculation of web members. Ills. 3600 w. Monit Tec—July 10, 1912. No. 34589 D.

See also Reinforced Concrete, under *Bridges*.

Causeways

Construction Methods Employed in Building the Galveston Causeway. Illus-

trated description of method of back-filling with hydraulic dredges located three miles from the site of the construction work. 2000 w. Eng Rec—July 13, 1912. No. 34432.

See also Sea Walls, under *Waterways and Harbors*.

Constantine

The Bridges of Constantine (Les Ponts de Constantine). M. Boisnier. Detailed description of the bridges across the Rummel gorge in Constantine, Algeria. Part I., in nine chapters, deals with the Sidi Rached bridge. Ills. and plates. Serial. 1st part. 50 pp. Ann d Ponts

We supply copies of these articles. See page 982. Order by title and number

et Chaussées — May-June, 1912. No. 34569 E + F.

Culverts

Reinforced Concrete Culverts (Eisenbetondurchlässe). Herr Kupfer. Suggestions for proper dimensions and notes on actual construction. Ills. 1900 w. Beton u Eisen — June 12, 1912. No. 34544 E.

Drawbridges

Small Vertical-Lift Draw-Bridges. Illustrates and describes two small vertical lift bridges operated by hand. 2000 w. Eng News—July 18, 1912. No. 34645.

A New Floating Bridge for Calcutta. Describes local conditions and gives illustrated descriptions of two designs for a bridge to replace the old pontoon bridge completed in 1874. Ills. and 2 plates. 2500 w. Engr, Lond—June 28, 1912. No. 34337 A.

The St. Louis River Drawbridge. Illustrated description of the principal parts for swinging and the electrical mechanism of this structure near Duluth. 1800 w. Eng Rec—June 29, 1912. No. 34121.

Erection

Collection of Practical Bridge Kinks. Illustrates and describes successful methods not generally used in bridge erection. 4500 w. Ry Age Gaz—July 19, 1912. No. 34669.

Methods of Construction the Celilo Bridge of the Oregon Trunk Railway. Illustrated description of the steel bridge across the Columbia River and its erection. 2500 w. Engng & Con—July 3, 1912. No. 34244.

Footbridges

Type of Suspended Footbridge for Signals, Installed at the Ends of the Batignolles Tunnel (Type de passerelles suspendues pour signaux installées aux extrémités du tunnel des Batignolles). M. Froebé. Details of the construction of a signal station on a footbridge. Ills. 2200 w. Rev Gen des Chemins de Fer—July, 1912. No. 34567 G.

Piers

Building Piers of Two Railroad Bridges in Wet Foundations. Illustrated description of the reconstruction of a bridge across the San Joaquin River in California. 2000 w. Eng Rec—July 13, 1912. No. 34436.

Pier Settlement on the Una Bridge, Brand River, Colo. Illustrated account of the trouble and its cause. 1000 w. Eng News—July 11, 1912. No. 34404.

Plate-Girders

Girder Bridge with Shallow Trough Floor. A bridge on the C. & N. W. Ry., near West Allis, Wis., is described. Ills. 1500 w. Eng Rec—July 13, 1912. No. 34435.

Reinforced Concrete

American Impressions of the Risorgimento Bridge at Rome. Henry Grattan Tyrrell. Illustrated discussion of the

most interesting features. 2500 w. Can Engr—June 27, 1912. No. 34132.

A Reinforced Concrete Highway Bridge at Columbus, Georgia. Illustrated description of a five-span structure made up of Melan arches with clear spans of 128 feet. 2000 w. Eng Rec—July 6, 1912. No. 34276.

Description of Reinforced Concrete Arch Over Current River, City of Port Arthur, Ontario. L. M. Jones. Ills. 2200 w. Can Engr—July 4, 1912. No. 34295.

Replacement

Removal of Girders on the Kiul Bridge on the East Indian Railway. Illustrated description of the work of regirdering a nine-span bridge. 1500 w. Ry Gaz, Lond—July 12, 1912. No. 34712 A.

Viaducts

A Heavy Short-Span Overhead City Bridge. Illustrates and describes details of a bridge on 11th St., New York, across eleven tracks of the N. Y. C. & H. R. R., having many interesting construction features. 1500 w. Eng Rec—July 20, 1912. No. 34679.

CONSTRUCTION

Beams

The Calculation of Continuous Beams with Unstable Moments of Inertia Upon Elastic Rotated Supports (Zur Berechnung kontinuierlicher Träger mit veränderlichem Tragheitsmoment auf elastisch drehbaren Stützen). A. Joho. Mathematical discussion on unsymmetrical beams. Diagrams. 3000 w. Schweiz Bau—June 15, 1912. No. 34530 D.

Buildings

The Service Equipment of a Combined Theatre and Office Building. W. A. Ehlers. Illustrated description of the equipment of Riggs' theatre and office building, Washington, D. C. 4000 w. Eng News—July 18, 1912. No. 34649.

A Notable Skyscraper. Illustrated description of the Bankers' Trust Building in New York. 2000 w. Cassier's Mag—July, 1912. No. 34913 B.

A New 35-Story Office Building in Seattle. Describes a building with pyramidal roof, grillage foundations on earth, girders with edge-bearing webs, wind-brace wall girders, etc. Ills. 2500 w. Eng Rec—July 6, 1912. No. 34277.

Reinforced Concrete Construction on the Offenbach Technical Academy (Die Eisenbetonkonstruktionen am Neubau der Technischen Lehranstalten Offenbach a. Main). Jean Wörrlein. Details of construction. Ills. 2600 w. Beton u Eisen—June 12, 1912. No. 34542 E.

See also Woolworth Building, under Construction.

Caissons

Caisson Foundations for the Seamen's Church Institute Building. Maurice Deutsch. Detailed description of foundation work for this New York 12-story building above curb. The lowest basement

floor is 31 feet below curb. 2500 w. Sch of Mines Qr—July, 1912. No. 34622 D.

Concrete Poles

A New Process of Making Concrete Poles. Illustrated description of the concrete pole machine and plant invented by R. M. Jones. 1200 w. Eng Rec—July 13, 1912. No. 34433.

Construction Camps

Discussion of Paper, "The Sanitation of Contractors' Camps and the Patrol of Watersheds." Discussion of papers describing the sanitary work at various places. 3500 w. Jour Assn of Engng Socs—June, 1912. No. 34618 C.

Fire Protection

Principles of Fire-Resisting Construction for Industrial Plants. F. P. Walthers. With introduction by Ira H. Woolson on "The Elements of Factory Fire Protection." First article of a series on the construction and arrangement of buildings and a study of the fire hazard. Ills. 5800 w. Engineering Magazine—Aug., 1912. No. 34757 B.

Floors

Floors and Floor Construction for Manufacturing Plants. Henry Grattan Tyrrell. Second of two papers. Deals with upper floors of factories and shops. Ills. 3500 w. Engineering Magazine—Aug., 1912. No. 34756 B.

Foundations

A Heavily Reinforced Concrete Foundation for a Power Station. Illustrated description of work at Terre Haute, Ind. 1200 w. Eng Rec—July 13, 1912. No. 34434.

Constructing the Foundations of Tall Warehouse Buildings. Illustrated description of construction work in Brooklyn, N. Y. 1500 w. Eng Rec—July 6, 1912. No. 34281.

Construction of Machinery Foundations. Arthur Connley. Describes concrete foundations and other types for both large and small machines, including heavy steel works steam engines. Ills. 2500 w. Ir Age—July 4, 1912. No. 34247 C.

See also Caissons, under *Construction*.

Piling

Concrete Piles. Maxwell M. Upson. Abstract of a paper before the Am. Soc. of Engng. Conts. Describes the different methods used, discussing advantages and giving general information. Ills. 2500 w. Ry Age Gaz—July 12, 1912. No. 34424.

Reclamation

Some Examples of Tidal Marsh Land Reclamation; Structures and Cost. Map, sections and brief description of land in Cumberland Co., New Jersey. 1000 w. Engng & Con—July 10, 1912. No. 34415.

Reinforced Concrete

The New Cellular Concrete Wall Along the Speedway, New York. Illustrates and describes details. 1200 w. Eng Rec—July 6, 1912. No. 34279.

Fire in a Reinforced Concrete Pulp Mill. Morton C. Tuttle. Illustrated account of a fire at So. Windham, Me., describing the building and discussing the results of the fire. 1000 w. Eng News—July 11, 1912. No. 34409.

A Reinforced Concrete Baseball Grand Stand. Illustrated description of a single deck structure with a roof of mill construction at Boston, Mass. 2500 w. Eng Rec—July 6, 1912. No. 34278.

See also Reinforced Concrete, under *Bridges*; Buildings, under *Construction*; Reinforced Concrete, under *Materials of Construction*, and Siphons, under *Water Supply*.

Roofs

The Glazed Roofing "Invincible" (La couverture vitrée "Invincible"). A. Moreau. Description of the Rendle system of joints for glass roofs. Ills. 3500 w. Bull Soc d'Encour—May, 1912. No. 34575 E + F.

Tunnels

A Compressed Air Tunnel Driven Without a Shield Through Wet Earth at Eastview. Describes a tunnel section carrying the Catskill Aqueduct through treacherous ground. 4000 w. Eng Rec—July 20, 1912. No. 34677.

Methods and Cost of Constructing Six Small Tunnels in Earth and Rock, Chicago Water Works. Myron B. Reynolds. A report of work carried out during 1906-1907. 4500 w. Engng & Con—July 3, 1912. No. 34241.

Lining the Snake Creek Tunnel. Oscar N. Friendly. Explains conditions and illustrates and describes this egg-shaped reinforced concrete lining. 3500 w. Eng & Min Jour—June 29, 1912. No. 34127.

The Beacon Hill Subway Tunnel in Boston. Wilbur W. Davis. Illustrates and describes a double-track concrete lined tunnel partly built by shield method and a station built under Tremont Street subway. 5500 w. Eng Rec—July 13, 1912. No. 34430.

Waterproofing

Waterproofing of Engineering Structures. W. H. Finley. Gives the experience of the writer with asphalt as a waterproofing material. General discussion. Ills. 12500 w. Jour W Soc of Engrs—June, 1912. No. 34616 D.

Woolworth Building

Construction of the Woolworth Building. Describes details of methods used in erecting this high building in New York City. Foundations carried through quicksand to rock and 23,000-ton 840-foot steelwork commenced before cellar was excavated. 4500 w. Eng Rec—July 27, 1912. No. 34807.

Steel Erection for the Woolworth Building. Brief illustrated description of work of interest on account of its magnitude and rapid execution. 2500 w. Eng Rec—June 29, 1912. No. 34118.

MATERIALS OF CONSTRUCTION

Asphalt

Development and Increase in the Use of Asphaltum. Harry Larkin. Explains the uses to which asphaltum is being applied. 2500 w. Jour Assn of Engng Soc's—July, 1912. No. 34886 C.

Bricks

Brick Drying. H. C. Russell. Discusses the so-called progressive dryers in which the brick, fresh from the machine, are placed, dried in the progressive principle, and removed to the kiln to be burned. 3500 w. Am Soc of Heat & Vent Engrs—June, 1912. No. 34745 N.

Cement

Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concretes, Together with Tests of Damp-proofing and Waterproofing Compounds and Materials. Rudolph J. Wig. and P. H. Bates. Report of investigations. Ills. 127 pages. Tech Papers of Bureau of Stand, No. 3—Aug. 22, 1911. No. 34495 N.

The Effect of High-Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete. Rudolph J. Wig. Investigations made to determine what acceleration in hardening could be obtained. Ills. 25 pages. Tech Papers of Bureau of Stand, No. 5—Sept. 5, 1911. No. 34497 N.

The Metamorphism of Portland Cement. Albert B. Pacini. An analysis of the changes in Portland cement and conditions affecting changes. 4000 w. Concrete-Cement Age—July, 1912. No. 34438.

Silica in Rotary Kiln Portland Cement. Dr. Otto Dormann. Trans. from *Zeit. für Angewandte Chemie und Centralblatt für Tech. Chemie*. A report of experiments and results in manufacturing practice. 1500 w. Engng—July 5, 1912. No. 34474 A.

Notes on the Question of Slag Cement (Beiträge zur Frage des Schlackenbetons). A. Knaff. Chemical analytical comparisons of various grades of slag cement. Diagrams. 2200 w. Serial. 1st part. Stahl u Eisen—June 6, 1912. No. 34500 D.

Clays

The Effect of Preliminary Heating Treatment Upon the Drying of Clays. A. V. Bleininger. Investigations undertaken to study the possibility of using excessively plastic clay are described and the results discussed. Ills. 53 pages. Tech. Papers of Bureau of Stand, No. 1—Dec. 6, 1910. No. 34494 N.

The Testing of Clay Refractories, with Special Reference to Their Load Carrying Capacity at Furnace Temperatures. A. V. Bleininger and G. H. Brown. Deals with fire clays at furnace temperatures. Ills. 78 pages. Tech. Papers of Bureau of Stand, No. 7—Dec. 15, 1911. No. 34499 N.

See also Terra Cotta, under *Materials of Construction*.

Concrete

Destruction of Cement Mortars and Concrete Through Expansion and Contraction. Abstract of a paper by A. H. White before the Am. Soc. of Test. Mat., giving results of investigations. 5000 w. Can Engr—June 27, 1912. No. 34131.

Concrete from Limestone Rubble (Beton von Kalksteinschotter). H. Nitzsche. Tables of tests made on such concrete. 2700 w. Beton u Eisen—June 12, 1912. No. 34545 E.

See also Concrete Testing, under *Measurement*; Sewers, under *Municipal*; and Concrete, under *Roads and Pavements*.

Paints

Density and Thermal Expansion of Linseed Oil and Turpentine. H. W. Bearce. Investigations with tabulated results. 27 pages. Tech Papers of Bureau of Stand, No. 9—April 15, 1912. No. 34601 N.

A New Method for Testing Paint Films and Preservative Coatings for Iron and Steel. W. C. Slade. Describes a proposed method which involves the electrolytic theory of corrosion, and utilizes the principle of alternate wetting and drying. 5500 w. Chem Engr—July, 1912. No. 34877 C.

Reinforced Concrete

Reinforced Concrete. T. E. Thain. Read before the S. Wales Inst. of Engrs. Reviews the history of this material, indicating the principal features in present practice and discussing the general systems for the use of the material. Ills. 4000 w. Ir & Coal Trds Rev—July 19, 1912. No. 34905 A.

The Use and Stability of Reinforced Concrete in Sea Water. Raymond Baffery. Read before the Nat. Assn. of Cement Users. Discusses the subject generally, and also under the heads of mass concrete, reinforced concrete structures, and reinforced concrete caissons. 3500 w. Cement & Engng News—July, 1912. No. 34396.

Failures of Reinforced Concrete Structures. Edward Godfrey. An examination of facts in regard to wrecked buildings, considering their design. General discussion. Ills. 1200 w. Pro Engrs Soc of W Penn—June, 1912. No. 34803 D.

Electrolysis of Reinforced Concrete. Harold P. Brown. Describes in detail the measures taken to stop the electrolytic action on the concrete of the Allentown packing house, and to repair the damage. Ills. 4500 w. Eng News—July 25, 1912. No. 34789.

Influence of Electric Currents on Reinforced Concrete (Einfluss des elektrischen Stromes auf Eisenbeton). Wilhelm Petry. Notes on the tests made by Prof. O. Berndt for determining electrolytic action. Ills. 1300 w. Beton u Eisen—June 12, 1912. No. 34543 E.

Reinforced Concrete Columns

Calculations for Tubular Columns of Reinforced Concrete (Le calcul des poutres tubulaires en ciment armé). Mathematical discussion on both the longitudinal and latitudinal bearing strengths. Diagrams. 2500 w. Génie Civil—June 15, 1912. No. 34584 D.

Reinforcing

Tensile Tests of Splices of Reinforcing Bars, Used in Washington Street Tunnel, Chicago. Illustrates and describes the methods of testing and states conclusions. 1000 w. Engng & Con—July 10, 1912. No. 34413.

Terra Cotta

The Manufacture of Terra Cotta for Building Purposes (La cuisson des terres cuites de batiment). M. F. Wattebled. Description of the process. Diagrams. 9000 w. Bull Soc d'Encour—May, 1912. No. 34576 E + F.

Timber

Microphotographs of the Structure of Wood. Studies of wood structures, explaining the difficulties, the success of an expert and the results obtained by such study. Ills. 1500 w. Wood Craft—July, 1912. No. 34236.

Varying Characteristics of the Same Woods. Samuel J. Record. On the distinctive differences in woods and their recognizable features. 1500 w. Wood Craft—July, 1912. No. 34235.

Timber Preservation

Azol: A New Preservative Material for Timber. William Manktelow. Information concerning a patent compound of metallic ammoniates, with an antiseptic acid having no deleterious action on wood or metals. 1500 w. Elec Rev, Lond—June 28, 1912. No. 34307 A.

Commercial Creosotes, with Special Reference to Protection of Wood from Decay. Carlisle P. Winslow. Information concerning the more important sources of wood preserving creosotes, the methods used in their production, etc. 5500 w. U S Dept of Agri, Circ 206—July 18, 1912. No. 34832 N.

Port Reading, N. J., Creosoting Plant. Illustrated description of this timber treating plant of the Philadelphia & Reading and Central of New Jersey. 2500 w. Ry Age Gaz—July 19, 1912. No. 34670.

MEASUREMENT**Cement Tests**

The Need of a More Severe Soundness Test for Cement. Henry S. Spackman. Presents the necessity of guarding against danger through latent power of expansion lying in the coarser particles of clinkers generally found in cement. Refers also to H. J. Force's paper on the same subject. 3000 w. Eng News—July 11, 1912. No. 34408.

See also Cement, under *Materials of Construction*.

Concrete Testing

Low-Cost Testing Machines for Concrete Beams and Slabs. Ernest McCullough. Drawings and description, with reports of improvement in the uniformity of the product. 1200 w. Eng News—July 25, 1912. No. 34791.

Rock Testing

The Physical Testing of Rock for Road Building, Including the Methods Used and the Results Obtained. Albert T. Goldbeck and Frank H. Jackson. Ills. 96 pages. U S Dept of Agri, Bul 44. No. 34831 N.

Rolling

Resistance to Rolling. Herbert Chatley. Formulates rules for the practical estimation of rolling resistances. 4500 w. Soc of Engrs—June, 1912. No. 34827 N.

Surveying

Precise Levelling in Canada. F. R. Reid. Read before the Ottawa Branch of the Royal Astronomical Soc. Deals with the methods employed by the Geodetic Survey. 5000 w. Can Engr—July 11, 1912. Serial. 1st part. No. 34486.

Short-Base Triangulation Methods on Reconnaissance and Exploratory Surveys. D. L. Reaburn. Explains how this method can be used to advantage on rapid surveys. 1500 w. Eng News—July 25, 1912. No. 34794.

Useful Surveyor's Instrument. Describes an instrument known as the rapid traverser, and its use. Diagrams. 1200 w. Eng & Min Jour—July 13, 1912. No. 34429.

A New Method of Linear Measurement in Underground Workings: Precise, Ordinary and Cursory Methods by Polygons (Eine neue Methode zur Längenmessung, u. zw. Präzisions-, gewöhnlichen und flüchtigen Messung der Polygonseiten des untertägigen Grubenzuges). Franz Köhler. Describes method for sloping shaft measurement. Ills. Serial. 1st part. 3600 w. Oest Zeit f Berg- u Hüttenwesen—June 29, 1912. No. 34562 D.

MUNICIPAL**Appraisals**

The Appraisal of Street Lighting Service. Decision by the Massachusetts Gas and Electric Light Commission in the Worcester street lighting case. 5000 w. Eng Rec—July 27, 1912. No. 34809.

Bridlington

Bridlington and Some of Its Municipal Works and Undertakings. Ernest R. Matthews. Read before the Inst. of Munic. & Co. Engrs. General statistics and descriptions of interest. Ills. 7500 w. Surveyor—July 5, 1912. No. 34464 A.

City Planning

The Prize Design for the Capital City of Australia. Plan and description of the proposed city, explaining the natural characteristics considered in the design. 2500 w. Engr, Lond—June 21, 1912. No. 34222 A.

East Ham, (Eng.)

Municipal Works at East Ham. J. E. W. Birch. Read before the Inst. of Munic. & Co. Engrs. Describes in detail the public works, giving particulars of interest. Also discussion. 8000 w. Surveyor—June 21, 1912. No. 34213 A.

Lowestoft

Twenty-five Years' Municipal Work at Lowestoft. G. H. Hamby. Read before the Inst. of Munic. & Co. Engrs. Gives general statistics and describes works at this town on the North Sea. Ills. 6000 w. Surveyor—June 28, 1912. No. 34317 A.

Refuse Collection

Refuse Collection in Columbus, Ohio. E. W. Stribling. Describes the buildings, equipment, methods and costs. Ills. 2500 w. Munic Jour—July 4, 1912. No. 34294.

Refuse Disposal

City Refuse Disposal at Seattle. George Holmes Moore. Gives the history of the refuse destructors, describing the latest type and giving operating results. Ills. 3500 w. Eng News—July 4, 1912. No. 34253.

The Disposal of a City's Waste. Franz Schneider, Jr. Illustrated account of how refuse is handled by New York and other cities. 2000 w. Sci Am—July 13, 1912. No. 34360.

Sanitation

Disinfectants, Antiseptics, and Deodorants, with Examples of Each. Hubert S. Jackson. Explanation of the office of each class. 1200 w. Surveyor—July 5, 1912. No. 34467 A.

See also Construction Camps, under *Construction*.

Sewage

See Purification, under *Water Supply*.

Sewage Disposal

Sewage and the Farmer. W. T. Sedgwick. Discusses the conservation of waste. 2000 w. Sci Am—July 13, 1912. No. 34363.

Methods for Differentiating Soils for Sewage Purification. Gilbert J. Fowler and William Clifford. Read before the Assn. of Mgrs. of Sewage Disposal Works at Wolverhampton. Considers the subject under various heads, describing the variable pressure porosimeter used, and the constant pressure porosimeter and experiments. 4500 w. Surveyor—July 19, 1912. No. 34888 A.

Fixed Sprays versus Revolving and Traveling Sprinklers. Reginald Brown. Read before the Assn. of Mgrs. of Sewage Disposal Works. Presents facts relating to the comparative cost of each system. Discussion. 6500 w. Surveyor—June 28, 1912. No. 34319 A.

An Electrical Sewage Disposal Plant. C. L. Edholm. Describes the process of treating by electrolysis as practiced in Oklahoma City, and in Santa Monica, Cal. Ills. 1000 w. Can Engr—July 18, 1912. No. 34660.

A Sewage Disposal System for a Country House. Cecil F. Harrington. Plans and explanation of a system and the necessary plumbing equipment. 2000 w. Dom Engng—July 6, 1912. No. 34282.

Sewage Disposal Plans for Jamaica Bay, New York. Information from the third preliminary report issued by the Metropolitan Sewerage Commission. 2000 w. Eng Rec—July 27, 1912. No. 34805.

Sewage Disposal Works at a Pennsylvania Hospital. Describes the plant at the State Hospital for the Chronic Insane at Wernersville. 4500 w. Eng Rec—July 20, 1912. No. 34680.

Sewage Pumping

Chattanooga's Sewage Pumping Station. Illustrated description, explaining conditions. 1200 w. Eng Rec—July 20, 1912. No. 34678.

Sewers

Concrete in Sewer Construction. W. J. Baird. An investigation of how concrete sewers compare with those of other materials, and description of forms used. 8000 w. Ap Sci—June, 1912. No. 34828 C.

The Plans and Specifications for the Construction of Sewer Catch Basins in Pittsburgh, Pa.—Specifications for Concrete and Brick Masonry in Sewers and Appurtenances. Ills. 2500 w. Engng & Con—July 17, 1912. No. 34609.

ROADS AND PAVEMENTS**Asphalt**

Trinidad and Bermudez Asphalts and Their Use in Highway Construction. Clifford Richardson. An account of these deposits, the manner of exploiting them and their industrial applications in highway construction. Ills. 3000 w. Pop Sci M—July, 1912. Serial. 1st part. No. 34260 C.

See also same heading, under *Materials of Construction*.

Asphalt-Macadam

Asphalt-Macadam. Cecil Nathan. Considers the characteristic properties of the material, and the methods of constructing such roads. 1500 w. Surveyor—July 19, 1912. No. 34887 A.

Concrete

Concrete Pavements—History and Summary of Practice. A brief history and summary given in a paper by K. H. Talbot in a paper before the Iowa Engng. Soc. 4000 w. Engng & Con—July 10, 1912. No. 34414.

One Course Concrete Sidewalks. H. M. Jones. Illustrates and describes work in Salt Lake City, Utah. 1800 w. Concrete-Cement Age—July, 1912. No. 34437.

Experimental Pavements

The Experimental Pavements on Hillside Ave., Queens Borough, New York City. Information from the official report of the committee. 3000 w. Engng & Con—July 24, 1912. No. 34774.

Highways

Crest of the Blue Ridge Highway. Joseph Hyde Pratt. Illustrated account of

an immense undertaking in road building in western North Carolina. 2500 w. *Mfrs' Rec*—July 11, 1912. No. 34385.

Massachusetts

The State Roads of Massachusetts. Brief history and explanation of current practice. 4000 w. *Eng Rec*—July 27, 1912. No. 34810.

State Highway Construction and Maintenance in Massachusetts. Arthur W. Dean. Reviews the work of the past 20 years, and discusses the things to be considered in connection with road construction. 4500 w. *Jour Assn of Engng Socs*—July, 1912. No. 34835 C.

Material

See Rock Testing, under *Measurement*, and Tube Milling, under *MINING AND METALLURGY, Ore Dressing and Concentration*.

Saskatchewan

The Administration of the Highway Improvement Vote in Saskatchewan. Abstract of a bulletin, issued by A. J. McPherson, explaining the general policy, the classification, road laws and administration, etc. 3500 w. *Can Engr*—July 4, 1912. No. 34296.

Specifications

Some Details and Specifications of the California Highway Commission. Details and specifications for the Morrison's Crossing—Marysville road, showing the general requirements. Ills. 2500 w. *Engng & Con*—July 3, 1912. No. 34242.

Surfacing

Treated Roads Laid Down in the Central District, Stirlingshire, Under the Grant from the Development and Road Improvement Funds Act, 1909, During the Year Ending May 15, 1912. D. R. Cox. Report concerning rocmac and tar-macadam surfaces. Discussion. 4000 w. *Surveyor*—June 21, 1912. No. 34214 A.

Wood Block

The New Specifications of the Board of Local Improvements of Chicago, Ill., for Creosote Wood Block Pavement. 3000 w. *Engng & Con*—July 17, 1912. No. 34607.

WATER SUPPLY

Aqueducts

The Storm King Crossing of the Hudson River, by the New Catskill Aqueduct, of New York City. J. F. Kemp. An interesting account of exploration work to determine the depth of bed-rock, and of other geological features of the tunnel. Ills. 2500 w. *Am Jour of Sci*—July, 1912. No. 34367 D.

Repairs to the Masonry of the Mauvages Aqueduct on the Canal from the Marne to the Rhine (*Réfection des maçonneries du souterrain de Mauvages sur le canal de la Marne au Rhin*). M. F. Launay. States how earth settlement caused deformation in the walls, and illustrates the mode of repair adopted. Plate. 3600 w. *Ann d Ponts et Chaussées*—May, June, 1912. No. 34568 E + F.

Bridlington

The Bridlington Waterworks. Sidney Charlesworth. Read before the Inst. of Munic. & Co. Engrs. Reviews the history and describes the present plant. 2500 w. *Surveyor*—July 12, 1912. No. 34714 A.

Conduits

A Water-Conduit Suspension Bridge, Feurs, France. Illustrated description extracted from an article by M. Betheder Matibet, in *Ann. des Ponts et Chaus.* 500 w. *Eng News*—July 25, 1912. No. 34796.

Consumption Statistics

Floor Area as a Unit for Estimating Water Consumption. William W. Brush. Explains a method used in New York City in areas occupied by high buildings. 2000 w. *Munic Engng*—July, 1912. No. 34632 C.

Dams

Arch Dam Design: The Constant-Angle Arch Dam. Lars Jorgensen. Analyzes the stresses in a curved dam and describes a new design of arch dam. 2500 w. *Eng News*—July 25, 1912. No. 34790.

Masonry Reservoir Dams: A Simple Formula for Their Design. F. C. Uren. Read before the Inst. of Munic. & Co. Engrs. Reviews the theories and methods of various engineers, and explains the writer's method. General discussion. 2500 w. *Surveyor*—July 19, 1912. No. 34886 A.

Repairing the Dam at Hatfield, Wisconsin. Illustrated description of work in which protection of 8000 cu. yds. of concrete placed in winter weather was secured by heating the aggregate and housing in the forms. 2500 w. *Eng Rec*—July 27, 1912. No. 34804.

The Austin Dam Failure. A discussion before the Boston Society of Civil Engineers, Dec. 12, 1911, introduced by a paper by Frank P. McKibben, giving details of construction and discussing the cause of failure. Ills. 14000 w. *Jour Assn of Engng Socs*—June, 1912. No. 34617 C.

Evaporation

Loss of Water by Seepage and Evaporation, Ferre Canal. W. B. Gregory. Report of measurements made in a typical rice irrigation canal to determine these losses. 1200 w. *Jour Assn of Engng Socs*—July, 1912. No. 34834 C.

Filters

Rapid Filters for Cheltenham Water Supply. Information concerning the supply and description of the filtration plant recently put into operation for city supply. 1000 w. *Engr, Lond*—June 28, 1912. No. 34339 A.

Fire Service

The Baltimore High Pressure Fire Service. Information from a report prepared by the Nat. Bd. of Fire Underwriters, describing the station and reporting tests. 2500 w. *Eng Rec*—July 13, 1912. No. 34431.

Ice Troubles

See Water Power, under *Water Supply*.

Irrigation

Irrigation Projects of the Canadian Pacific Railway Company in Alberta. A. S. Dawson. Map and illustrated description of the Calgary project especially. 3500 w. Can Engr—July 18, 1912. Serial. 1st part. No. 34662.

Leakage

Methods and Cost of a Leakage Survey for Lancaster, Pa., Water Works. F. H. Shaw. Explains conditions and the inspection work found necessary. 1700 w. Munic Engrg—July, 1912. No. 34633 C.

Malaria

Screening as an Anti-Malaria Measure. Dr. A. J. Orenstein. On the value of screened dwellings in malarial regions. 2000 w. Eng Rec—June 29, 1912. No. 34119.

Pipe Lines

Laying a Water-Works Intake Line in 65 Feet of Water. Plan and description of work at Marquette, Mich. 1500 w. Eng Rec—June 29, 1912. No. 34117.

The Construction of Pipe Arches (Ueber die Ausbildung von Rohrbogen). A. Bühler. Considerations for coefficients of velocity, temperature, etc., in laying out such arches for water lines along bridges and other occasions for rises in gradient. Ills. 2500 w. Schweiz Bau—June 8, 1912. No. 34528 D.

See also Wood Pipe, under *Water Supply*.

Pollution

The Self-Pollution of Water by Natural Growths. J. H. Garrett. Read before the Inst. of Water Engrs. Briefly considers these troublesome organisms, and their effect on water supplies. 1600 w. Surveyor—July 5, 1912. No. 34465 A.

Water Pollution Control in Ohio. Gives the greater part of the opinion of the Court, compelling cities and villages to establish sewage purification plants. 4000 w. Eng News—July 11, 1912. No. 34400.

Pumping Station

Methods and Cost of Constructing a Pumping and Lighting Station at Kilbourn, Wis. R. G. Walter. Plans and description of a plant on the Wisconsin River. 2500 w. Engrg & Con—July 24, 1912. No. 34775.

The New Pumping Station at Nîmes (La nouvelle usine élévatrice des eaux de Nîmes). M. Déthiollaz. Illustrated description of plant, pumps and line. Plate. 7500 w. Génie Civil—June 22, 1912. No. 34585 D.

Purification

The Bacterial Purification of Water and Sewage. Earle B. Phelps. Considers methods utilized in water and sewage purification. 3000 w. Sci Am—July 13, 1912. No. 34362.

Drinking Water in Industrial Plants. John Sebroff. Discusses the industrial loss due to water-borne diseases, and the

importance of furnishing a pure supply for the use of workmen. 2500 w. Ind Engrg—July, 1912. Serial. 1st part. No. 34770 C.

French Tests of Water Purification Methods. Report of tests conducted by a special commission of Marseilles, comparing results. 3000 w. Munic Jour—July 18, 1912. Serial. 1st part. No. 34663.

The Use of Copper-Sulphate in Purifying Water Supplies. George Embrey. Read before the Inst. of Water Engrs. Also discussion. 2200 w. Surveyor—July 5, 1912. No. 34466 A.

Modern Treatment of Residual Waters (Traitement moderne des eaux résiduaires). Lucien Cavel. Touching on several methods of purification with special attention to intensive biological treatment. Ills. 4800 w. Tech Mod—July 15, 1912. No. 34582 D.

See also Feed Water, under *MECHANICAL ENGINEERING, Steam Engineering*.

Siphons

Inverted Siphons on the Los Angeles Aqueduct. Brief description of the 12.03 miles of syphons at canyon and valley crossings. 1000 w. Eng Rec—June 29, 1912. No. 34120.

Reinforced Concrete Inverted Siphons on a Main Canal. Illustrates and describes structures in Glenn Co., Cal. 1200 w. Eng Rec—July 27, 1912. No. 34806.

Methods and Costs of Reinforced Concrete Siphon Construction on the Los Angeles Aqueduct. D. L. Reaburn. Illustrates and describes the construction of the Whitney, and South Antelope siphons as representative, giving some costs. 2500 w. Engrg & Con—July 3, 1912. No. 34243.

Sterilization

Violet Ray Sterilization of Drinking Water in Chicago. Illustrated description of the plant. 1000 w. Eng Rec—July 27, 1912. No. 34811.

Waste

Some Notes on the Use, Misuse, and Waste of Public Water Supplies: Can Misuse and Waste Be Remedied? William Whitehouse. Read before the Inst. of Munic. Engrs. Also general discussion. 7000 w. Surveyor—June 28, 1912. No. 34320 A.

Water Power

The Power Situation in the State of New York. A. H. Perkins. Considers the water power demands and supplies of the State, and outlines the plans of the Conservation Commission for promoting development. 4000 w. Engineering Magazine—Aug., 1912. No. 34758 B.

The Influence of Ice on Water Power Development. H. T. Barnes. Abstract of a paper before the Can. Elec. Assn. Describes the three distinct forms of ice and the effects of each, and gives a few rules for avoiding ice troubles. 2500 w. Can Engr—June 27, 1912. No. 34134.

Water-Works

The Municipal Water-Works at Corn-
ing, California. C. F. Braun. Brief illus-
trated description of a well-designed typi-
cal plant. 1500 w. Eng Rec—June 29,
1912. No. 34122.

The Derwent Valley Waterworks. Il-
lustrated detailed description of this great
undertaking for supplying water to Lei-
cester, Derby, Sheffield, and Nottingham.
4500 w. Engr, Lond—July 19, 1912. No.
34901 A.

New Waterworks for Stockport. Plan
and illustrated description of the works,
with review of their history and opera-
tion. 3500 w. Engr, Lond—July 12, 1912.
No. 34719 A.

Well-Boring

Combined Percussion and Rotary Well-
Boring Machine for Argentina. Illus-
trated description. 900 w. Engng—July
5, 1912. No. 34473 A.

Wood Pipe

The Design and Specifications of the
Sacramento Water Supply Wood Pipe
Line of the El Paso & Southwestern Ry.
Co., in New Mexico. 3000 w. Engng &
Con—July 17, 1912. No. 34608.

WATERWAYS AND HARBORS**Bulkheads**

A Large Timber Bulkhead Under 168-
Ft. Head. Arthur W. Tidd. Drawings
and description of a temporary bulkhead
used in connection with work in the Cats-
kill aqueduct. 1200 w. Eng News—July
25, 1912. No. 34792.

Canals

Dimensions for Canals of Heavy Traffic;
A Summary of Practice in Leading Coun-
tries. Abstract of a summary made by
Alfred Noble of the seven reports, out-
lining practice in as many countries, pre-
sented at the recent Int. Cong. of Nav.
10500 w. Engng & Con—July 24, 1912.
No. 34772.

Enlargement of the Kaiser Wilhelm
Canal. Editorial on the enlargement of
this great canal which joins the Baltic to
the North Sea. 1600 w. Engng—June
21, 1912. No. 34221 A.

See also Evaporation, under *Water
Supply*; and Detroit River, under *Water-
ways and Harbors*.

Crossings

An Economic Comparison of Bridges,
Ferry Bridges and Tunnels as Crossings
of Navigable Waterways. From a report
by A. Forti, to the Int. Cong. of Nav.
Outlines a particular case and examines
the characteristics of the three systems
under comparison. Ills. 1500 w. Engng
& Con—July 24, 1912. No. 34776.

Detroit River

The New Canalized Channels in the
Detroit River. James Cooke Mills. Illus-
trated account of navigation improvement
works for the United States and Canada.
3500 w. Cassier's Mag—July, 1912. No.
34911 B.

Docks

Method and Cost of Constructing a
Concrete and Steel Ore Dock for the Du-
luth & Iron Range R. R. Leland Clapper.
Illustrations, with detailed description.
4000 w. Engng & Con—July 17, 1912.
No. 34610.

The 50,000-Ton Ore Dock at Marquette.
Illustrates and describes the design and
erection of a wood, steel, and concrete
structure for storing iron ore and deliver-
ing it rapidly to lake boats. 2500 w. Eng
Rec—July 6, 1912. No. 34274.

The Lumber Dock at Balboa, Canal
Zone. George R. Goethals. Illustrated
description of the design and construction
of the first reinforced concrete dock of the
type likely to be generally used at Pan-
ama. 3000 w. Eng Rec—July 20, 1912.
No. 34675.

Dredging

U. S. Government Contract Dredging.
Gives a summary of cost of contract
dredging, and information concerning the
work. 2500 w. Eng News—July 11, 1912.
No. 34402.

Dry Docks

Construction of Dry Dock No. 4, Brook-
lyn Navy Yard. H. S. Rinker. An ac-
count of the experience of the different
contractors, and illustrated detailed de-
scription of the work as finally executed.
5500 w. Eng News—July 25, 1912. No.
34788.

Dry Dock New York Navy Yard. Il-
lustrated description of Drydock No. 4,
and its construction. 2500 w. Marine
Rev—July, 1912. No. 34421 C.

The 32,000-Ton Floating Dock for the
Medway. Illustrated description of the
largest and heaviest floating dock which
has been built in Great Britain. 1200 w.
Engr, Lond—July 19, 1912. No. 34903 A.

Floods

The Flood Problem of Pittsburgh. Ken-
neth C. Grant. Map, illustration and ac-
count of conditions, with report of in-
vestigations of damages, causes and
methods of protection. 4500 w. Engr,
Lond. July 19, 1912. Serial. 1st part.
No. 34899 A.

The Great Mississippi River Flood of
1912. A report of T. G. Dabney, chief
engineer. Yazoo-Mississippi delta levee
district. 3000 w. Eng Rec—July 6, 1912.
No. 34280.

Lock Gates

Accident to Gates of Lock 22, Welland
Canal, near Thorold, Ont. Emile Low.
Brief illustrated account of the serious
accident occurring on June 20, 1912. No.
34399.

Panama Canal

The Panama Canal and Its Influence on
Ocean Rates and Traffic. J. Russell
Smith. Map, and the probable re-arrange-
ment of routing, and a discussion of far
reaching effects expected. 3500 w. Ry
Gaz, Lond—July 12, 1912. No. 34713 A.

The Railways and the Panama Canal. Argument over the toll question; discusses the discriminatory effect of the free toll policy, and proposed restrictions on vessel ownership. 4500 w. *Ry Age Gaz*—July 19, 1912. No. 34667.

The Locks of the Panama Canal (Les Écluses du Canal de Panama). L.-G. Levy. Description of the constructive and operative features of the locks from the French point of view. Ills., Serial. 1st part. 2200 w. *Tech Mod*—June 15, 1912. No. 34580 D.

Ports

Notes on the Work in Progress and Projected at the Port Saint Nazaire (Note sur les Travaux en cours et en projet au Port de Saint Nazaire). Ed. Epinay. Description of the enlargement work under way and to be done at this port. Ills. 7000 w. *Ann d Ponts et Chaussées*—May, June, 1912. No. 34570 E + F.

The Work of Enlarging and Improving the Port of Havre (Les travaux d'agrandissement et d'amélioration du port du Havre). Ch. Dantin. Outline of the works under way and the plans for adding new anchorage within extended new dikes. Ills. and maps. 10,000 w. *Génie Civil*—June 29, 1912. No. 34586 D.

River Improvement

Methods of River Improvement by Regulation and Dredging—Possibilities of Reservoirs. Abstract of a paper by William W. Harts, read before the Int. Cong. of Nav. A review of American practice. 7500 w. *Engng & Con*—July 24, 1912. No. 34773.

Sea Walls

Lowestoft Sea Defences. G. H. Hamby. Describes the troubles experienced on this coast of the North Sea and what has been done for the protection during the past 25 years. Also discussion. 4000 w. *Surveyor*—June 28, 1912. No. 34318 A.

ELECTRICAL ENGINEERING

COMMUNICATION

Radiotelegraphy

Notes on the Operation of Inductively Coupled Receiving Sets in Wireless Telegraphy. J. O. Mauborgne. Abbreviated from U. S. Army Signal School, Conference No. 14. Gives results of investigation. 3000 w. *Elect'n, Lond*—July 19, 1912. No. 34885 A.

The Goldschmidt High-Frequency Alternator for Wireless Telegraphy and Telephony. Detailed description. 1200 w. *Elect'n, Lond*—July 19, 1912. No. 34882 A.

The New Marconi Works at Chelmsford. Plan and description of works for the manufacture of the many devices used in connection with wireless telegraphy. 1500 w. *Engr, Lond*—June 28, 1912. No. 34338 A.

See also Transmitters, under *Communication*.

Solar Radiation

The Disturbing Influence of Solar Radiation on the Wireless Transmission of Energy. Nikola Tesla. Presents new ideas in regard to the propagation of electrical waves through the air. 2000 w. *Elec Rev & W Elect'n*—July 6, 1912. No. 34299.

Submarine Cables

A Method of Determining the Distance of a Partial Disconnection in a Submarine Cable. Charles E. Hay. Describes a method successfully applied. 500 w. *Elec Rev, Lond*—June 28, 1912. No. 34309 A.

The Semi-Bridge System for Duplexing Submarine Cables. J. Kajiura. Diagrams and explanation of the arrange-

ment. 1200 w. *Elect'n, Lond*—July 5, 1912. No. 34462 A.

A Peculiar Fracture in a Submarine Cable. An account of fractures in a cable between Gutzlaff and Amoy, belonging to the Great Northern Telegraph Co. Ills. 1000 w. *Elec Rev, Lond*—July 19, 1912. No. 34597 A.

Submarine Power Cable Installation at Sacramento, Cal. J. Paulding Edwards. Illustrates and describes the method of laying and of making connections of a cable transmitting power across a river, and also to a draw span of a bridge. 2000 w. *Elec Ry Jour*—July 6, 1912. No. 34293.

Telephony

Long Distance Cable Telephony. Its Explanation by Means of the Electron Theory (Die Kabel Telephonie auf Grosse Entfernungen. Ihre Erklärung mittels der Electronentheorie). Herr Kareis. Discussion on this theory a probable explanation. 3500 w. *Electrotechniker*—June 25, 1912. No. 34514 D.

See also Wiring, under *Distribution*.

Transmitters

A Direct Method for the Determination of the Radiation Efficiency, Earth Resistance and Radiation Resistance of a Wireless Transmitter. J. Erskine-Murray. Describes a method in which a small auxiliary antenna is used. 2000 w. *Elect'n, Lond*—July 12, 1912. No. 34708 A.

DISTRIBUTION

Circuit Breakers

Recent Developments in the Art of Circuit-Interrupting Devices for High Voltages. Charles J. Hejda. Illustrated description of the construction and prin-

ciple of operation of the latest type of S. & C. fuse. 1500 w. Elec Rev & W Elect'n—July 27, 1912. No. 34817.

Supply Systems

The Construction of Distribution Systems for Outlying Systems and Smaller Plants. S. Bingham Hood. Abstract of paper read before the Can. Elec. Assn. General discussion, with analysis of pole costs, pole fittings, and related matters. 4500 w. Can Engr—July 11, 1912. Serial. 1st part. No. 34485.

Wiring

Some Unusual Construction in Open Wiring. H. G. Wilson. Brief illustrated description of three deviations from usual practice. 500 w. Elec Rev & W Elect'n—June 29, 1912. No. 34141.

Wiring Old Houses. Terrell Croft. Begins an account of a business campaign in Pittsburgh and vicinity. 2000 w. Elec Wld—July 13, 1912. Serial. 1st part. No. 34443.

Wiring in Cold Storage Rooms. W. J. Canada. Calls attention to precautions necessary in wiring such plants. 800 w. Elec Wld—July 6, 1912. No. 34287.

Wiring for Electric Hoists. Illustrated explanation of control circuits. 1500 w. Elec Rev & W Elect'n—July 27, 1912. No. 34816.

Wiring for Power and Light in Printing Offices. Illustrates and describes interesting installations. 2200 w. Elec Rev & W Elect'n—July 13, 1912. No. 34418.

The Wiring of Large Buildings for Telephone Service. Frederick L. Rhodes. Illustrates and describes methods that have proved satisfactory. Ills. 6000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34858 F.

DYNAMOS AND MOTORS

A. C. Generators

Excitation of Alternating-Current Generators. D. B. Rushmore. Considers only the excitation of alternating-current synchronous generators. Ills. 8500 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34866 F.

A. C. Motors

Electric Braking of Tri-Phase Series Commutator Motors (Ueber elektrische Bremsung von Drehstromserien-Kollektormotoren). Kl. Schenfer. Mathematical discussion deducing curves. Diagrams. 9000 w. Elek u Masch—June 30, 1912. No. 34534 D.

Brakes

A New Self-Adjusting Prony Brake. J. Dennis Coales. Line drawing and description of a new type of prony brake. 1200 w. Elect'n, Lond—July 19, 1912. No. 34883 A.

Brushes

Setting Motor Brushes. J. S. Kinney. Notes on methods of setting to obtain satisfactory operation. Diagrams. 1500 w. Power—July 23, 1912. No. 34701.

Commutation

Commutation. F. W. Carter. A discussion of various theories relating to commutation and their practical application. 2500 w. Elec Wld—June 29, 1912. No. 34143.

Condensers

Synchronous Condensers. C. T. Mosman. Explains theoretically how synchronous motors may be used to control the power factor by adding wattless current to the circuit. 3000 w. Gen Elec Rev—July, 1912. No. 34226 C.

Controllers

Electric Controlling Devices. G. J. Kirchgasser. Explains the action of motors and illustrates and describes devices for starting and regulating them in practice. 3500 w. Mach, N Y—July, 1912. No. 34167 C.

D. C. Machines

Direct-Current Machines; Installation and Operation. George E. Edwards. Suggestions from the standpoint of practical operation. 4000 w. Min & Engng Wld—July 27, 1912. No. 34872.

Generators

Some Experiences with a Unipolar Generator. Editorial on a machine described by B. G. Lamme in a paper before the Am. Inst. of Elec. Engrs. Ills. 2000 w. Engng—July 19, 1912. No. 34896 A.

Induction Motors

Single-Phase Induction Motors. W. J. Branson. Aims to develop a complete vector analysis of single-phase induction motor performance as the basis for an accurate circle diagram applicable to motors of even the smallest commercial sizes. 4500 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34865 F.

Reactance

Armature Reactance in D. C. Machines with Parallel Winding (Over de ankerreactie van gelijkstroommachines met zuivere parallelwikkeling). W. Luloffs. Mathematical discussion on four-pole machines. Diagrams. 9000 w. De Ingenieur—June 8, 1912. No. 34563 D.

Regulation

Direct-Current Generator Regulation. P. Amsler. Illustrates and describes a simple device giving a fine regulation of pressure. 800 w. Elec Wld—July 27, 1912. No. 34820.

Pressure Regulators. S. J. Watson. Abstract of a paper read before the Incor. Munic. Elec. Assn. Considers regulators which may be provided as a separate piece of apparatus with the object of maintaining a constant pressure on bus bars, or constant speed on direct current motors. 800 w. Mech Engr—July 12, 1912. No. 34715 A.

Rotary Converters

Current Forms in the Coils of a Synchronous Converter. J. H. Morecroft. Gives photographs of the current forms in the different coils of a small rotary, with

explanatory remarks. 500 w. Elec Wld—June 29, 1912. No. 34144.

Electric Mine Operations—Rotary Converters. Stuart Rice. Calls attention to some of the more recent tendencies in the application of electric current. 1800 w. Min & Engng Wld—June 29, 1912. No. 34137.

Single Phase

Single-Phase Commutator Motors. R. E. Hellmund and E. W. P. Smith. Considers various commutating-pole arrangements. 3000 w. Elec Jour—July, 1912. No. 34841.

See also same heading, under STREET AND ELECTRIC RAILWAYS.

Synchronous Motors

Synchronous Motor Performance. Nicholas Stahl. Explains methods for determining the performance without resort to complicated diagrams or equations. 3500 w. Elec Wld—July 20, 1912. No. 34695.

Connections for Synchronizing. Harold W. Brown. Diagrams and explanatory notes. 2000 w. Elec Jour—July, 1912. No. 34842.

Turbo Alternators

Curtis Turbo Alternators. Describes the theory upon which the working of the Curtis turbine is based, and its application to the building of large turbo-generator sets. Ills. 2500 w. Elect'n, Lond—July 12, 1912. Serial. 1st part. No. 34704 A.

Vibrations

Vibration Produced by Motor Generators. Elmer E. Hall. Explains the utilization of a special recorder for determining the causes of vibratory disturbances. Ills. 1500 w. Elec Wld—July 27, 1912. No. 34821.

Windings

Standard Instruments and Transformer Windings. Charles C. Garrard. Critical consideration of some recommendations of the British Engineering Standards Committee. 1700 w. Elect'n, Lond—June 28, 1912. No. 34311 A.

ELECTRO-CHEMISTRY

Canada

Electrochemical and Electrometallurgical Developments in Canada. S. Dushman. Abstract of paper before the Am. Elec. Chem. Soc. Describes the character and scope of plants now employed, and discusses future developments throughout the country. 5000 w. Elect'n, Lond—June 28, 1912. No. 34310 A.

Corrosion

Corrosion by Electrolysis. C. H. Ehrenfeld. Discusses the effect of electrolysis upon parts of icemaking and refrigerating machinery and the prevention. 2000 w. Ice & Refrig—July, 1912. No. 34234 C.

Corrosion of Iron and Steel. William R. Fleming. From a paper read before the Cincinnati section of the Am. Chem. Soc. Reports experiments to confirm the

electrolytic theory. Ills. 1500 w. Ir Age—July 11, 1912. No. 34359 C.

See also Reinforced Concrete, under CIVIL ENGINEERING, *Materials of Construction*.

Nitrogen

Utilizing Coke-Oven Gases for the Recovery of Nitric Acid from Atmospheric Nitrogen. Plan and description of Hauser apparatus at Nuremberg. 2500 w. Ir & Coal Trds Rev—June 28, 1912. No. 34341 A.

ELECTRO-PHYSICS

Dielectrics

The Conductivity of Dielectrics. Dr. J. A. Fleming. Gives results of recent investigations of dielectric phenomena. 2000 w. Sci Am Sup—July 20, 1912. No. 34657.

Electrodynamics

A Derivation of the Fundamental Relations of Electrodynamics from Those of Electrostatics. Leigh Page. Deduces the fundamental laws of electrodynamics from those of electrostatics. Mathematical. 2500 w. Am Jour of Sci—July, 1912. No. 34368 D.

Resistance

Variation of the Electrical Resistance of Oxides with Temperature. A. A. Somerville. A study of resistance as a function of temperature of the oxides. 500 w. Met & Chem Engng—July, 1912. No. 34176 C.

GENERATING STATIONS

Central Stations

Notes on the Economical Operation of Small Central Stations. H. H. Stephens. Read before the Oklahoma Gas, Elec., & St. Ry. Assn. Calls attention to possible economies. 1200 w. Elec Rev & W Elect'n—June 29, 1912. No. 34140.

Steam in Central Station Use. Newton Harrison. A study of the different kinds of steam and heat it contains, with related information. 3000 w. Cent Sta—July, 1912. No. 34416.

See also Electrification, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Costs

Discussion on "A Method of Studying Power Costs with Reference to the Load Curve and Overload Economics." Discussion at New York, Feb. 9, 1912, of paper by George I. Rhodes. 5000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34871 F.

Economics

Current Supply from Hydroelectric Plants (Stromversorgung aus Wasserkraftwerken). Emil Frey. Reviews the resources from electric generating stations. 5500 w. Elek Kraft u Bahnen—June 4, 1912. No. 34520 D.

Hydro-Electric

A Mammoth Norwegian Power Plant. Illustrated description of the great plant which furnishes power for the manufacture of saltpeter, and for other applica-

tions. 2000 w. Sci Am—July 27, 1912. No. 34778.

The Hydro-Electric Plant of the Adammello Electric Supply Co. Illustrated description of an important development in Italy. 2500 w. Elect'n, Lond—July 19, 1912. Serial. 1st part. No. 34881 A.

The Dakota Power Co.'s Hydro-Electric Plant. Jesse Simmons. Illustrates and describes a development on Rapid Creek, about 9 miles from Rapid City. 1000 w. Min & Engng Wld—July 13, 1912. No. 34446.

Developing a Unique Idaho Water-Power. Illustrated description of the harnessing 181-foot head of the "Thousand Springs" beneath lava outflow, and construction of 3,000 h. p. plant. 600 w. Elec Wld—July 6, 1912. No. 34284.

Developments of the Great Falls Power Company. Illustrated description of plant on Missouri River, near Great Falls, Mont., generating 21,000 k. w. and transmitting energy 152 miles at 102,000 volts to mines at Butte and Anaconda. 3000 w. Elec Wld—July 6, 1912. No. 34283.

Electricity in Northwest Washington. Illustrates and describes the generating and distribution system of the Whatcom Co. Ry. & Lght. Co. of Bellingham, Wash. 5000 w. Elec Wld—July 20, 1912. No. 34694.

Hydroelectric Plant at Estacada, Ore. Illustrates and describes the new generating plant of the British Railway, Light & Power Co. on Clackmas River. 3000 w. Elec Wld—July 13, 1912. No. 34440.

The San Joaquin Hydro-Electric Power Installation. F. C. Perkins. Illustrated description of this development in southern California. 1500 w. Sci Am Sup—July 6, 1912. No. 34289.

New San Joaquin Power Plant. Howard H. Bliss. Illustrated description of a 16,000 k. w. hydroelectric plant. 1200 w. Power—July 16, 1912. No. 34451.

Hydro-Electric Development in Western North Carolina. N. Buckner. Illustrates and describes power plants of the Asheville district. 1500 w. Cassier's Mag—July, 1912. No. 34915 B.

Electricity in Canadian Goldfields. Illustrated description of the system of the West Kootenay Power & Light Co., Ltd., in the mining region around Rossland, B. C. 3000 w. Elec Wld—July 27, 1912. No. 34818.

The Hydroelectric Station at Gatun Spillway. Describes how surplus water at Gatun Lake will be utilized to supply electrical energy for the Panama Canal zone. 2500 w. Eng Rec—July 27, 1912. No. 34808.

Isolated Plants

The Lay-Out and Erection of Power-House Plant. E. Kilburn Scott. Abstract of a paper before the Jun. Inst. of Engrs. Discusses the plant, its arrange-

ment, foundations, erecting, air gap and poles, commutator and brushes, connecting up, cleaning, and drying out. 6500 w. Ir & Coal Trds Rev—July 5, 1912. No. 34480 A.

Loads

Hints on Developing a Motor Load. Walter E. Rogers. Suggests motor hiring and explains the scheme. 3000 w. Elec Rev, Lond—July 12, 1912. No. 34659 A.

Power Factor

Power Factor, Its Influence and Value. D. H. Ross. Read before the Can. Elec. Assn. Outlines the benefits of a high power factor. 800 w. Can Engr—July 25, 1912. No. 34875.

Improving Power-Factor of an Industrial Load. E. R. Spencer. An account of the power factor correction at the pipe and tube plant of the Spang-Chalfant Co. at Etna, a suburb of Pittsburgh. Ills. 1000 w. Elec Jour—July, 1912. No. 34839.

Reliability

Means for Securing Reliability and Maintaining Continuity of Supply. Frank Ayton. Abstract of a paper before the Incor. Munic. Elec. Assn. Suggests precautions which would prevent interruptions to supply of both steam and electrical plant. Discussion. 4800 w. Elect'n, Lond—June 21, 1912. No. 34208 A.

LIGHTING

Illumination

Industrial Illumination and the Average Performance of Lighting Systems. C. E. Clewell. A discussion of industrial conditions, illumination factors, efficiency, and related matters. Ills. 3000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34856 F.

Practical Industrial Illumination Problems. C. E. Clewell. Discusses the location and spacing of lamps, the selection of type and size, etc., 4000 w. Elec Jour—July, 1912. No. 34837.

Lighting Large Assembly Rooms. Albert Scheible. Considers the requirements and comments on the seven rules presented at the Int. Cong. at Dresden. Also editorial. 2000 w. Elec Wld—June 29, 1912. No. 34145.

See also same heading, under *Measurement*.

Lamps

Metal Filament Lamps of High Power in Use on Railways. H. Marchand. An explanation of what has been accomplished with these lamps. 3200 w. Bul Int Ry Cong—July, 1912. No. 34735 G.

Note on the Use of High Power Metal Filament Lamps by the Administration of the Belgian State Railway. J. B. Thonet. A report of the installations and the results. 1900 w. Bul Int Ry Cong—July, 1912. No. 34736 G.

Lamp Standards

Further Notes on the Design and Efficiency of American Street Lighting Standards. L. Crouch. Illustrates standards

and discusses the questions of efficiency, capital and operating costs of new equipments. 2200 w. Elec Rev, Lond—July 19, 1912. No. 34596 A.

Mercury-Vapor

French and German Quartz Tube Mercury-Vapor Lamps. Warren H. Miller. Describes the design and operation and gives data as to cost and service. Ills. 900 w. Elec Wld—July 27, 1912. No. 34819.

Progress

Electric Lighting and Power Development. George Wilkinson. Abstract of a presidential address before the Incor. Munic. Elec. Assn. Reviews the development in England. 2500 w. Mech Engr—June 28, 1912. No. 34323 A.

Radiography

Symphony in Stereoscopic Radiography. P. H. Eijkman. An account of work in Roentgen stereoscopy. Ills. 1500 w. Jour Fr Inst—July, 1912. No. 34629 D.

MEASUREMENT

Hysteresis Loss

An Accurate Examination of the Steinmetz Index for Transformer Iron, Stalloy and Cast Iron. F. Stroude. Abstract of a paper read before the Physical Soc. Describes a careful series of determinations of hysteresis loss on these materials. 1000 w. Elect'n, Lond—July 19, 1912. No. 34880 A.

Illumination

A Photographic Method for Recording Candle-Power Distribution Curves. Herbert E. Ives and M. Luckiesh. Describes a photographic method peculiarly applicable to arc lamps and other fluctuating sources. Ills. 3000 w. Elec Wld—July 20, 1912. No. 34696.

The New Laboratory for Illumination Testing at the Zürich Gas Plant (Das neue Lichtmess-Laboratorium des Gaswerks Zürich). A. Weiss and E. Ott. Describes laboratory, its duties and equipment. Ills. 2300 w. Schweiz Bau—June 15, 1912. No. 34529 D.

Permeability

Permeability Measurements with Alternating Current. L. T. Johnson and J. D. Ball. Deals with the general relations between maximum flux density, maximum exciting current, and magnetizing current. Ills. 1500 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34863 F.

Power Efficiency

Determination of Power Efficiency of Rotating Electric Machines. E. M. Olin. Gives a method for establishing the ratio of load loss to the losses indicated by the no-load measurements. 5500 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34854 F.

Resistance

To Measure an Alternating-Current Resistance and Compare It with the Direct-Current Resistance—Electro-Dynamometer Method. Edwin F. Northrup.

Describes method. 2000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34855 F.

Units

The Myrawatt. H. G. Scott and Haylett O'Neill. Introduces a new unit of power which, if accepted, will afford a basis of comparison of all converters of energy, thermal and mechanical. 700 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34870 F.

See also Units of Energy, under MECHANICAL ENGINEERING, *Measurement*.

POWER APPLICATIONS

Agricultural

Electricity on the Farm. Putnam A. Bates. An illustrated discussion of the many applications of electricity for the betterment of the farmers' conditions and improved efficiency. 7000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34869 F.

Department Stores

Electrical Construction in Department Stores. Notes on equipment and installation. Ills. 2500 w. Elec Rev & W Elect'n—July 6, 1912. No. 34298.

Electricity in the Department Store. E. F. Tweedy. Gives engineering and cost data for illumination and motors based upon central-station service. 2500 w. Elec Wld—July 6, 1912. No. 34286.

Electric Drive

Equipment and Wiring in an Electrically Driven Fire-Pump Installation. Illustrated detailed description of a modern plant in Chicago. 2500 w. Elec Rev & W Elect'n—July 13, 1912. No. 34417.

Electric Drive for Paper Machines. J. S. Henderson, Jr. Explains the operating characteristics of paper machines, types of drive, control, etc. Ills. 2500 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34859 F.

Application of Electric Drive to Paper Calenders. E. C. Morse. Considers the finishing department of a paper mill and particularly the motor drives for three types of paper calenders. Ills. 7000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34868 F.

Electric Drive for Brass-Finishing Plants. Discusses features of such installations and presents tabulated information relative to five typical plants. Ills. 4500 w. Elec Rev & W Elect'n—July 20, 1912. No. 34693.

Electric Drive for Carpet Cleaning. Illustrated description of a Chicago plant, and information concerning a number of combined plants. Ills. 1800 w. Elec Rev & W Elect'n—July 6, 1912. No. 34297.

Electricity in Sash and Door Plants. Illustrated article explaining the advantages of motor-drive in this field, and giving tabulated information. 4000 w. Elec Rev & W Elect'n—July 27, 1912. No. 34815.

Motor-Operated Roll Lathes. E. M. Wise. Explains the advantages of ad-

justable speed motors, and considers the selection of a motor for a roll lathe. Ills. 1000 w. *Elec Jour*—July, 1912. No. 34843.

See also *Electric Power*, under MINING AND METALLURGY, *Iron and Steel*, also under *Mining*.

TRANSMISSION

Cables

Laying Out a Cable System Through the River Trave. Brief illustrated description of the methods employed. 700 w. *Sci Am Sup*—July 20, 1912. No. 34655.

The Inter-Relation of Capacity in Three-Phase Three-Core Cables. W. T. MacCall. Mathematical determination of the capacity current. 500 w. *Elec Rev*, Lond—June 21, 1912. No. 34206 A.

See also *Submarine Cables*, under *Communication*.

Conductors

Aluminum Conductors for Overhead Transmission Lines. Charles L. Johnson. Describes British practice. 2000 w. *Elec Wld*—July 6, 1912. No. 34285.

The Characteristics of Copper and Aluminum Overhead Line Conductors. E. V. Pannell. Gives a few rules for the comparison of line conductors and deductions applying to British conditions. 3000 w. *Can Engr*—July 18, 1912. No. 34661.

Converters

Three-Phase to Direct Current Conversion for Railway Purposes (Drehstrom - Gleichstrom - Umformerwerke für Bahnzwecke). Herr Idelberger. A brief sketch of the three types of machines for such conversion, and description of some of each type. Ills. 9300 w. *Elek Kraft u Bahnen*—June 4, 1912. No. 34518 D.

Corona Losses

Corona Losses Between Wires at High Voltages. C. Francis Harding. Gives results of tests recently made at Purdue University and compares the results obtained by various observers upon such a basis as to aid in the confirmation of formulae which may be generally used in transmission line design. Ills. 2000 w. *Pro Am Inst of Elec Engrs*—July, 1912. No. 34853 F.

Earthing

"Earthing" as Defined in the Electricity Rules. W. Bolton Shaw. Paper and discussion before the Assn. of Min. Elec. Engrs. (Lancashire Branch). 4000 w. *Ir & Coal Trds Rev*—June 21, 1912. No. 34224 A.

Fault Location

Localizers, Suppressors, and Experiments. E. E. F. Creighton and J. T. Whittlesey. Application of localizers of faulty feeders and an arcing ground suppressor to the system of the Public Service Electric Co., and description of several experimental studies. Ills. 8500 w. *Pro Am Inst of Elec Engrs*—July, 1912. No. 34862 F.

High Tension

The High Tension Transmission System of the Hydro-Electric Power Commission of Ontario. Illustrates and describes this high-tension steel tower system operating at a potential 110,000 volts. Serial. 1800 w. *Can Engr*—July 25, 1912. No. 34874.

Line Design

The Determination of Tramway Networks. A. J. Lawson. Urges the value of using scale models of tramway systems in order to study the drop with various arrangements of feeders. 2000 w. *Elect'n*, Lond—July 12, 1912. No. 34705 A.

Treatise on the Calculation of Networks (Verfahren zur Berechnung elektrischer Leitungsnetze). H. Frohman. Mathematical discussion. Diagrams. 3000 w. *Elektrotech u Masch*—June 16, 1912. No. 34515 D.

Line Sag

Simplified Sag Formulas for Overhead Wires and Cables. H. V. Carpenter. Gives a logarithmic chart for showing the relation between the tension, sag and span-length in copper and aluminum transmission lines. 1200 w. *Elec Wld*—July 13, 1912. No. 34442.

Line Supports

Flexible Supports for Overhead Transmission Lines. Alfred Still. Derives simple methods for calculating stresses in the remaining conductors when one of a group breaks. 3000 w. *Elec Wld*—July 13, 1912. No. 34441.

Protective Devices

Relay Protective Systems. L. L. Elden. A summary of American practice in the application of relay protection. Ills. 6000 w. *Pro Am Inst of Elec Engrs*—July, 1912. No. 34861 F.

Means of Protecting High Tension Circuits Against Overloads and Atmospheric Discharges (Les Moyens de protéger les Lignes à haute tension contre les Sur-tensions et les Décharges atmosphériques). S. Capart. Describes and discusses four of the recently devised protective methods. Ills. 4800 w. *Bull Soc Belge d'Electriciens*—April, 1912. No. 34566 E.

Transformers

Care and Operation of Transformers. W. M. McConahey. From a paper before the Nat. Elec. Lgt. Assn. Directions for the shipping and testing of transformers and the necessary care. 1600 w. *Power*—July 16, 1912. No. 34454.

Some Interesting Points Concerning Transformer Operation. James A. Seager. Notes on operating experience. 2000 w. *So Elect'n*—July, 1912. No. 34493.

Determination of Polarity of Transformers for Parallel Operation. W. M. McConahey. Considers various combinations. Diagrams. 2500 w. *Elec Jour*—July, 1912. No. 34840.

Voltage Regulation

Essays on Voltage Regulation. F. W. Shackelford. Outlines methods of regu-

lation and gives suggestions for laying out a new system or reconstructing an old one. 2500 w. Gen Elec Rev—July, 1912. Serial. 1st part. No. 34233 C.

Wires

The Properties of Electrical Wires (Mitteilungen über die Eigenschaften von Fahrleitungen). Sigm. Guggenheim. Results of tension, torsion, concussion and other tests on various grades of wires.

4000 w. Elek Kraft u Bahnen—June 24, 1912. No. 34526 D.

MISCELLANY

Economics

Electricity as a Factor in Civilization. Dr. J. Siegel. Abstract of a lecture before the Soc. of Elect'ns, Berlin. Discusses its influence in industry, commerce, and in the home. Ills. 2000 w. Sci Am Sup—July 27, 1912. No. 34780.

INDUSTRIAL ECONOMY

Arbitration

Arbitration. Onward Bates. A discussion of this method of settling disputes, and the methods of conduct that should govern, urging that engineers establish a code. General discussion follows. 31500 w. Jour W Soc of Engrs—June, 1912. No. 34615 D.

Combinations

The Place of the Great Business Combinations in Modern Industrial Life. Hon. Frederick P. Fish. Abridged address. Explains their advantages and the conditions which have made them necessary. 6000 w. Jour Worcester Poly Inst—July, 1912. No. 34830 C.

Cost Methods

Cost Methods That Give the Executive Control of His Business. Benjamin A. Franklin. Eighth and concluding article of a series aiming to show how cost accounts may help the manager. 3500 w. Engineering Magazine—Aug, 1912. No. 34755 B.

Developments

Looking Forward. Editorial notes on impending developments. 9000 w. Casier's Mag—July, 1912. Serial. 1st part. No. 34914 B.

Education

Education and Economy. A critical discussion of engineering educational methods in England. 1800 w. Engr, Lond—June 28, 1912. No. 34335 A.

Industrial Education. Preliminary report of the educational committee. Ills. 10800 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34867 F.

The Idol of Quick Returns. David H. Browne. Extracts from an address at Kingston, Ont., on the real objects of university education. 2500 w. Met & Chem Engng—July, 1912. No. 34170 C.

Shopwork for Engineering Students. Winslow H. Herschel. Considers college shops, their defects, and proposed substitutes. 5000 w. Eng News—July 18, 1912. No. 34647.

The Wentworth Institute. Charles L. Hubbard. Illustrates and describes methods of a trade school for training shop foremen and workmen. 2500 w. Mach, N Y—July, 1912. No. 34162 C.

We supply copies of these articles. See page 982. Order by title and number

The Future and Scope of the Technical Mechanic (Zukunft und Ziele der technischen Mechanik). Ferdinand Wittenbauer. Rectorial address before the Graz Technical High School. 4800 w. Zeitschr des Ver deutscher Ing—June 29, 1912. No. 34558 D.

Efficiency

Personal Efficiency. Charles Frederick Loweth. Address before the College of Engineering, Urbana, Ill. 4000 w. Bul Univ of Ill—May 20, 1912. No. 34375 N.

Engineering

The Works of the Engineer and the World's Peace. George Duncan Snyder. Reviews the work of the engineer showing its influence. 3000 w. Engineering Magazine—Aug., 1912. No. 34752 B.

Estimating

Preparing Estimate Specifications. Joseph V. Woodworth. An example of how specifications should be prepared to enable a manufacturer to estimate on the manufacture of an article in quantities. 800 w. Am Mach—July 4, 1912. No. 34201.

Exhibitions

The Royal Agricultural Society's Show. An account of the Royal Show being held at Doncaster, describing exhibits. Ills. 6000 w. Engng—July 5, 1912. Serial. 1st part. No. 34472 A.

Industrial Diseases

Industrial Lead Poisoning. James O. Clifford. Describes plumbism, its symptoms, effects, prevention, dangers, etc. 3500 w. Min & Sci Pr—July 6, 1912. No. 34353.

Labor

See same heading, under RAILWAY ENGINEERING, *Permanent Way and Buildings*.

Management

Industrial Administration and Scientific Management. Forrest E. Cordullo. Discusses the importance of efficient administration and what constitutes scientific management. 6500 w. Mach, N Y—July, 1912. Serial. 1st part. No. 34163 C.

The Planning Department, Its Organization and Function. H. K. Hathaway. Explains the functions of planning departments and describes a plant having

such a department in service. 4500 w. Ind Engng—July, 1912. Serial. 1st part. No. 34768 C.

The Mnemonic Symbolizing of Stores under Scientific Management. Howard G. Benedict. Read at Cleveland before the Soc. to Promote the Sci. of Management. Explains a system for symbolizing general stores. 3000 w. Ind Engng—July, 1912. Serial. 1st part. No. 34771 C.

The Lodge & Shipley Stores System. E. Stubbs. Explains the system under which lathe parts are economically manufactured in quantities. Ills. 1200 w. Am Mach—July 25, 1912. No. 34740.

Organization

Organization in Engineering. Henry Marison Byllesby. Address delivered before the College of Engineering, Urbana, Ill. 3500 w. Bul Univ of Ill—May 13, 1912. No. 34374 N.

Organization in Electrical Undertakings. C. M. Shaw. Abstract of paper read before the Incor. Munic. Elec. Assn. Deals with the proper organization of the staff and methods of carrying out the work. Discussion. 4500 w. Elect'n, Lond—June 21, 1912. No. 34210 A.

Patent Law

The More Fundamental Principles of Patent Law. Edwin J. Prindle. Their exposition in a popular form in connection with a typical industrial development, for the purpose of establishing a patent monopoly along any line. Ills. 8000 w. Jour Am Soc of Mech Engrs—July, 1912. No. 34760 D.

Profit Sharing

Profit Sharing in a Wisconsin Plant. Explains features of the stock distribution plan followed by the Baker Manufacturing Co., of Evansville, Wis. 2500 w. Ir Age—July 18, 1912. No. 34639 C.

Strikes

A Review of Coal Strike in England. Cecil Toone. Discusses the effects of the strike on central stations and other industries. 3000 w. So Elect'n—July, 1912. No. 34492.

Timekeeping

A Uniform Timekeeping System Which Will Eliminate Pay-Day Disputes. R. O. McDill. Remarks on systems used, with details of a system found satisfactory. 1200 w. Engng & Con—July 17, 1912. No. 34606.

MARINE AND NAVAL ENGINEERING

Battleships

Progress of Warships and Machinery Under Construction in England. Half-yearly report of the progress in this work in royal and private shipyards in the country. 1500 w. Engr, Lond—July 12, 1912. No. 34721 A.

Analysis of the Trial Trips of the Battleship Florida. Sidney G. Koon. 1200 w. Int Marine Engng—July, 1912. No. 34155 C.

H. M. S. "Conqueror." Describes this British battleship and its equipment, reporting trials. Ills. 700 w. Engng—June 21, 1912. No. 34220 A.

Bunkers

The Firing of Bunker Coal and Coal Cargoes. Gives important points made in a report in connection with bunker fires. 1200 w. Engng—July 12, 1912. No. 34718 A.

Collapsible Boat

A New Type of Collapsible Boat. N. C. Johnson. Illustrated detailed description of a boat that can be carried as hand luggage. 4000 w. Rudder—July, 1912. No. 34349 C.

Diesel Engines

Russian High-Speed Marine Diesel Engines. J. Rendell Wilson. Illustrates and describes engines built by Ludwig Noble. A vertical Diesel engine of 180 h. p. that weighs but 33 lbs. per h. p. for marine uses. 2200 w. Int Marine Engng—July, 1912. No. 34154 C.

Dredges

Recovering Burned Dredge Machinery. Lewis H. Eddy. An account of work of recovery requiring 104 days. Much the same methods were used as are employed in dismantling a dredge. 1500 w. Eng & Min Jour—July 13, 1912. No. 34425.

See also Pipe Friction, under MECHANICAL ENGINEERING, *Measurement*.

"Imperator"

The Largest Ship Yet Constructed. An illustrated description of the 65,000-ton liner "Imperator." 900 w. Sci Am—July 6, 1912. No. 34288.

Lightships

The New Lightship for the First Station on the Elbe (Das neue Feuerschiff für die erste Station der Elbe). L. Graemer. Description of the ship, and particularly of the light, its accompanying machinery, and siren attachment. Ills. and plates. Serial. 1st part. 2400 w. Schiffbau—June 26, 1912. No. 34533 D.

"Maine"

The U. S. Battleship "Maine." J. T. Bucknill. Deals with points relating to the recovery of the wreck, and considers the theory of an external explosion as a myth. Ills. 5000 w. Engng—June 21, 1912. No. 34218 A.

The Condition of the "Maine" After 13 Years' Submersion. Maximilian Toch. Illustrates and describes the conditions of different materials examined. 1500 w. Eng News—July 4, 1912. No. 34252.

Motor Boats

Launching of the Trans-Atlantic Liner Detroit at Port Clinton. Illustrated detailed description of a boat built on Lake Erie to make the trip from Detroit via the Erie Canal and Hudson River, and thence to Europe. 1000 w. Rudder—July, 1912. No. 34350 C.

Oil Engines

The Application of the Junkers Oil Engine to Marine Work. Illustrates the engines for a vessel under construction, explaining the arrangements. 2000 w. Int Marine Engng—July, 1912. No. 34152 C.

See also Diesel Engines, under MARINE AND NAVAL ENGINEERING.

Propulsion

Ship Propelling Machinery of Alternative Designs. Editorial review of the discussion of the relative merits and cost of different types of ship-propelling machinery before the N.-E. Coast Inst. of Engrs. & Shipbuilders. 3000 w. Engng—July 19, 1912. No. 34895 A.

Electrical Equipment for the Propulsion of the U. S. Collier Jupiter. Eekil Berg. Detailed description of the principal features of the design and operation, with report of tests. Ills. 1500 w. Gen Elec Rev—Aug., 1912. No. 34952 C.

Salvage

Raising the Italian Cruiser "San Giorgio" (Le Renflouement du Croiseur Cuirasse Italien "San Giorgio"). E. Lignolles. An account of the method of using compressed-air tanks as floats for raising the ship off a submerged reef. Ills. 4500 w. Génie Civil—June 15, 1912. No. 34583 D.

Shipbuilding

Shipbuilding and Engineering Works at St. Nazaire. History and illustrated description of these French works. 4000 w. Engr, Lond—July 5, 1912. No. 34476 A.

Messrs. Workman, Clark & Co.'s Works at Belfast. Reviews the history of this shipbuilding industry and illustrates and describes the plant. Plates. 9500 w. Engng—July 19, 1912. No. 34893 A.

Harland & Wolff's Works at Belfast. Illustrated detailed description of the shipbuilding and engineering works, with a review of their history. 12900 w. Engng—July 5, 1912. Serial. 1st part. No. 34471 A.

The Draftsman in Shipbuilding. S. C. Jenkins. Read before the Local Assn. of Marine Draftsmen, at Norfolk, Va. Reviews changes and development of shipbuilding and gives an outline of the duties of a ship-draftsman. 1800 w. Int Marine Engng—Aug., 1912. No. 34970 C.

Signaling

History and Development of Submarine Signaling. H. J. W. Fay. Outlines the history of the art of submarine signaling

and describes in detail the apparatus now being used. Ills. 6000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34857 F.

Steamships

The Strength of Ships. Notes on a book recently published in Germany, written by Felix Pietzker, and of importance to shipbuilders. 2000 w. Engr, Lond—June 28, 1912. No. 24336 A.

Alaska Steamship Company's New Steamship Cordova. Illustrated description of a steel screw steamship, constructed for passenger and freight service. 1200 w. Int Marine Engng—July, 1912. No. 34153 C.

Side Wheel Steamer City of Detroit III. Illustrated description of the largest side wheel passenger steamer for service between Detroit and Buffalo. 2500 w. Marine Rev—July, 1912. No. 34420 C.

Submarines

Modern Submarine Boats for the United States Navy. Illustrated detailed description of these boats and their operation, with related information. 2500 w. Int Marine Engng—July, 1912. No. 34151 C.

The Uses of Electricity in Submarines (Die Anwendung der Elektrizität auf Unterseebooten). Herr Arnold. A critical review on submarine power as discussed by A. Bezzi. Serial. 1st part. 4000 w. Schiffbau—June 12, 1912. No. 34532 D.

Tonnage

The Tonnage Laws. Arthur R. Liddell. Considers the objections to the present system of assessment of dues by tonnage. 1000 w. Engr, Lond—July 12, 1912. No. 34722 A.

Torpedo Boats

The Torpedo Cruisers "Catamarca" and "Jujuy" of the Argentine Marine (Die Torpedokreuzer "Catamarca" und "Jujuy" der argentinischen Marine). Herr Züblin. Description of these cruisers with results of trials. Ills. and plates. Serial. 1st part. 1600 w. Schiffbau—June 12, 1912. No. 34531 D.

Torpedo Control

The Wirelessly Directed Torpedo. Benjamin F. Missrer. Illustrated account of some new experiments in this field. 1000 w. Sci Am—July 20, 1912. No. 34652.

Transporter Ship

The Transporter Ship "Kangaroo" for Submersible Boats. Illustrates and describes a vessel built for the transport of submarine boats, and also used to carry bulky loads. 700 w. Engng—July 19, 1912. No. 34894 A.

Vibration Producer

Preventing Collisions at Sea. Sir Hiram Maxim. Outline description of a mechanical application of the bat's sixth sense and its use for warning of obstructions at sea. 2500 w. Sci Am—July 27, 1912. No. 34779.

MECHANICAL ENGINEERING

AERONAUTICS

Aerodynamics

The Centre-of-Pressure Travel on Aeroplane Surfaces and on Birds' Wings. Elisha N. Fales. Reports results of experimental research at the aeronautical laboratory of the Mass. Inst. of Tech. 2500 w. Engng—June 28, 1912. No. 34331 A.

See also Hydrodynamics, under *Hydraulic Machinery*.

Aeromechanics

Elements of Theoretical Aeromechanics. A. F. Zahm. Abstracted from a forthcoming book. The present number deals with aerostatics. 2500 w. Sci Am Sup—July 13, 1912. Serial. 1st part. No. 34366.

Aircraft

Aircraft for Sea Service. F. L. M. Boothby. Discusses airships and aeroplanes, the service for which each is suited, future aircraft and related subjects. General discussion. 16000 w. Jour Roy U Serv Inst—June, 1912. No. 34190 N.

Airships

Destruction of the Airship "Akron." An account of the career of Melvin Vaniman, and his tragic end. 2000 w. Sci Am—July 13, 1912. No. 34361.

Aviation

I. The Structures of the Future in Relation to Aviation. Horace Cubitt. II. Some Suggestions for By-Laws and Regulations in Relation to Aviation. B. Wyand. Two papers before the Inst. of Munic. Engrs., discussed together. 10000 w. Surveyor—June 21, 1912. No. 34215 A.

Some Practical Information on Aviation (Quelques renseignements pratiques sur l'aviation). Robert Esnault-Pelterie. A general review of the chief constructive features of the modern aeroplane, covering the various types. Describes the various styles of monoplanes and biplanes, tails, chassis, motors, propellers, etc. Ills. and plates. 95 pp. Mem Soc Ing Civ de France—April, 1912. No. 34565 G.

AUTOMOBILES

Adler

The 15 h.p. Adler. Illustrated description of this latest addition to the Adler cars. 1200 w. Autocar—July 20, 1912. No. 34595 A.

Atlas

1913 Atlas Motor. Illustrates and describes the many improvements in the latest model of Knight double-sleeve engine. 3000 w. Automobile—July 25, 1912. No. 34785.

Cadillac

The 20-30 h.p. Cadillac. Illustrates and describes details of this 4-cylinder car. 1500 w. Autocar—July 6, 1912. No. 34455 A.

Carburetors

Studies on Motor Engine Carburetors (Studie über die Vergaser von Motorfahrzeugen). A. Heller. General analysis of carburation with studies on most efficient mixtures. Ills. and diagrams. 8000 w. Zeitschr des Ver deutscher Ing—July 6, 1912. No. 34561 D.

An Indicator for Spray-Carburetors (Indikator für Einspritz-Vergaser). Georg Bergmann. Results of a series of tests on carburetor adjustment, with curves. Ills. and plate. Serial. 1st part. 4000 w. Motorwagen—June 20, 1912. No. 34541 D.

Car Lighting

Dynamo Lighting for Motor Vehicles. J. D. Morgan. Abstract of paper read before the Birmingham (Eng.) Sec. of the I. E. E. States the requirements for self-governing vehicle dynamos, and considers electrically self-governing dynamos and mechanically regulated dynamos. 4000 w. Horseless Age—July 17, 1912. No. 34642.

Chalmers

'13 Chalmers Out. Illustrates and describes features appearing in the new models. 2500 w. Automobile—July 25, 1912. No. 34786.

Commercial Vehicles

See Motor Trucks, under *Automobiles*.

Fire Apparatus

The Development of the Motor Fire-Engine; the Results and Value of Past and Future Trial Runs with Motor Fire-Engines (Die Entwicklung der Motorspritzen, die Ergebnisse der stattgefundenen und der Wert der geplanten Prüfungsfahrten mit Motorspritzen). August Bauschlichter. Reviews progress and discusses present defects as determined by the trials. 7000 w. Motorwagen—June 10, 1912. No. 34540 D.

The Driving Engines and Pumps of the Motor Fire-Apparatus (Die Fahrgestelle und Pumpen der Feuerwehr-Motorspritzen). Herr Schwerdtfeger. Comprehensive review of several types of German fire-trucks, with results of their duty trials. Ills. and plates. 10000 w. Motorwagen—June 10, 1912. No. 34539 D.

Gears

Worm and Helical Gears as Applied to Rear Axles. Frank Burgess. Abstract of paper before the S. A. E. convention. Outlines the qualifications necessary in an efficient worm gear. 1200 w. Automobile—July 11, 1912. No. 34390.

Processes in Production of Automobile Transmission Gears. Walter Betterton. Read before the Graduates Sec. of the Birmingham (Eng.) branch of the Inst. of Auto. Engrs. Describes the materials

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used and processes. Ills. 5000 w. Mach, N Y—July, 1912. No. 34161 C.

See also Hydraulic Transmission, under *Automobiles*.

Hudson

New Hudson Models Reveal Many Changes. Illustrates and describes the 37 horse-power chassis and its use for a touring car and a roadster. 1700 w. Horseless Age—July 3, 1912. No. 34271.

Two New 1913 Hudsons. Illustrates and describes details of the new six-cylinder model. 3500 w. Automobile—July 11, 1912. No. 34392.

Hydraulic Transmission

Hydraulic Transmission. Dr. Hele-Shaw's solution of the hydraulic transmission for motor cars is illustrated and described. 2500 w. Auto Jour—June 29, 1912. No. 34306.

The Hele-Shaw Rotary Pump and Motor. Reviews a system notable on account of the simplicity of its construction and of the means adopted for the reduction of friction. Ills. 3000 w. Engng—June 21, 1912. No. 34219 A.

The Hele-Shaw Hydraulic Transmission. An infinitely variable gear in place of clutch, gear-box and differential. Ills. 1800 w. Autocar—June 22, 1912. No. 34205 A.

Ignition

Two Point Ignition—Its Advantages and Its Future. Albert L. Clough. Gives the substance of replies to inquiries made of manufacturers. 2500 w. Horseless Age—July 10, 1912. No. 34411.

Knox

Knox Line for 1913 Includes a New Six Cylinder Car. Illustrates and describes four new models, especially the six-cylinder car. 2500 w. Horseless Age July 11, 1912. No. 34391.

Motor Test

A Comprehensive Motor Test. Herbert Chase. Report of a laboratory test of a 6-cylinder motor with special reference to thermal and volumetric efficiencies, friction losses and composition of exhaust gases. 3500 w. Horseless Age—July 24, 1912. No. 34787.

Proper Testing of Motors, Determining Various Factors. Herbert Chase. Abstract of paper before the S. A. E. convention. On testing methods needed in present practice. 2500 w. Automobile—July 15, 1912. No. 34391.

Motor Trucks

Motor Transportation for the Contractor. Rollin W. Hutchinson. Gives facts and figures as to operation from tests by two large contracting companies. Ills. 2500 w. Concrete-Cement Age—July, 1912. No. 34439.

Locomobile 5-Ton Truck. Illustrates and describes features of interest. 2500 w. Automobile—July 4, 1912. No. 34251.

Motor Sizes and Drive Ratios for Commercial Vehicles. E. P. Batzell. Abstract

of paper and discussion before the S. A. E. convention. Discusses motor sizes, economical requirements, etc. 6000 w. Automobile—July 11, 1912. No. 34389.

The Commercial Automobile (Les Véhicules Industriels Automobiles). Capt. Renaud. Reviews development, and discusses tractive resistance, etc. Serial. 1st part. 2400 w. Tech Mod—June 15, 1912. No. 34579 D.

Performance

"K"—A Basis for Comparison Between Cars and for Estimating their Performances. J. W. Roebuck. Notes and data relating to investigations into the performances which should be obtained from any kind of patrol-engined vehicle. Also editorial. 9500 w. Autocar—June 22, 1912. No. 34204 A.

Pullmans

Three Pullmans. Illustrates and describes details of new models. 2200 w. Automobile—July 18, 1912. No. 34636.

Silencers

Silencers. W. G. Aston. Discusses the theory and construction of devices designed to reduce the noise of the exhaust. Ills. 3500 w. Autocar—July 13, 1912. No. 34764 A.

Singer

The Singer Cars. Illustrates and describes improvements in recent cars of this British company. 1700 w. Auto Jour—July 6, 1912. No. 34456 A.

Speed

How to Change Speed. Helpful suggestions. 2000 w. Auto Jour—June 22, 1912. No. 34203 A.

Tires

Tyre Economy. Eric W. Walford. Suggestions for reducing the wear and prolonging the life of tyres. Ills. 2000 w. Autocar—July 13, 1912. No. 34763 A.

Tractors

Petrol-Motor Tractors. Illustrates and describes powerful tractors suitable for use on large farms or for contractors having heavy haulage. 1000 w. Engng—June 28, 1912. No. 34332 A.

Six-Horse-Power Single-Cylinder Traction Engine with Superheater. Illustrated description of an engine exhibited at the recent Royal Agricultural Show. 500 w. Engng—July 19, 1912. No. 34898 A.

Universal Joints

Kardan Joints in Automobile and Boat Construction (Kardangelenke im Automobile- und Bootsbau). Karl Regensteiner. An examination into the kinematic and dynamic conditions covered by the Kardan universal joint. Ills. and diagrams. 5400 w. Zeit d Mitt Motor Ver—June 15, 1912. No. 34538 D.

Valve Timing

Valve Timing of Four and Six Cylinder Automobile Motors. E. P. Batzell. Considers the effects of overlapping of inlet and exhaust periods and of piston speed on the most advantageous valve timing.

5000 w. Horseless Age—July 10, 1912. No. 34410.

COMBUSTION MOTORS

Diesel Engines

Diesel Engine Design. Paul H. Russel. Considers present tendency in the designs, types, particularly the four-cycle single-acting engines. Diagrams. 2000 w. Mech Wld—June 28, 1912. Serial. 1st part. No. 34326 A.

Present and Future Importance of the Diesel Engine (L'importanza attuale e l'avvenire dei motori Diesel). Mario Dornig. This first paper discusses the principal types of Diesel engines and their present functions. Ills. Serial. 1st part. 3600 w. Monit Tec—June 20, 1912. No. 34588 D.

See also same heading, under MARINE AND NAVAL ENGINEERING, and Fuels, under *Combustion Motors*.

Engine Rating

American Practice in Rating Internal Combustion Engines. T. C. Ulbricht and C. E. Torrance, Jr. Investigations to determine empirical formulæ which would represent average practice of American manufacturers in the rating of gas engines of the stationary type. 1500 w. Power—July 23, 1912. Serial. 1st part. No. 34702.

Fuels

Tar and Tar Oil as Driving Mediums for the Diesel Engine (Teer und Teeröl als Treibmittel für den Dieselmotor). Herr Rath. Results of various grades of coal-tar and its products. 5600 w. Glückauf—June 22, 1912. No. 34510 D.

Experiments on a 480 H.P. Diesel Engine Driven with Tar Oil (Untersuchung eines mit Teeröl betriebenen 480 PS-Dieselmotors). Herrn Bütow and Döbbelstein. Description of the engine, followed by results of the tests on this fuel. Ills. 2400 w. Glückauf—June 22, 1912. No. 34509 D.

Gas Analysis

A Modified Orsal-Apparatus. E. J. Billings. Illustrated description of a combined apparatus for sampling and analyzing furnace gases. 900 w. Power—July 16, 1912. No. 34452.

Gas Engines

Desirable Improvements in American Gas Engine Design. C. F. Hirshfeld. Calls attention to faults found in many American gas engines, and discusses critically points in practice. Ills. 3500 w. Mach, N Y—July, 1912. No. 34168 C.

The Design and Construction of a New Gas Engine. Illustrated description of the Cooper twin-tandem gas engine and some applications. 2000 w. Ir Trd Rev—July 11, 1912. No. 34388.

Gas Furnaces

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Gasoline Motors

Gasoline Industrial Locomotives. Frank C. Perkins. An account of difficult condi-

tions to which the internal combustion motor has been adopted. Ills. 1000 w. Mines & Min—July, 1912. No. 34184 C.

Gas Producers

The Status of the Gas Producer and of the Internal-Combustion Engine in the Utilization of Fuels. Robert Heywood Fernald. A report of investigations made by the U. S. Government. Ills. 42 pages. U S Bureau of Mines—Tech Paper 9. No. 34370 N.

The Slagging Type of Gas Producer, with a Brief Report of Preliminary Tests. Carl D. Smith. Information concerning this type and results of tests. Ills. 3500 w. U S Bureau of Mines—Tech Paper 20. No. 34800 N.

Gas Turbines

Holzwarth's Gas Turbine. Drawings and description of the gas turbine designed by H. Holzwarth and E. Junghaus. 1000 w. Mech Engr—July 5, 1912. No. 34468 A.

The Efficiency of the Gas Turbine (Der Wirkungsgrad der Explosions-Gasturbine). Hans Holzwarth. Experimental tests, tabulated and plotted by curves. In two parts. Part I. 1800 w. Zeitschr des Ver deutscher Ing—June 15, 1912. No. 34553 D.

The Efficiency of the Gas Turbine (Zum Wirkungsgrad der Explosionsturbine). A. Stodola. Mathematical and experimental discussion. Ills. 5000 w. Zeitschr des Ver deutscher Ing—June 22, 1912. No. 34557 D.

Gaswasher

A Centrifugal Gaswasher. Walther Feld. Illustrated description of this method of purifying and cooling blast-furnace and producer gases, and applications made. 1500 w. Met & Chem Engng—July, 1912. No. 34178 C.

HEATING AND COOLING

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Heating and Ventilating the Northwestern University Buildings. J. M. Stannard. Describes a system of hot-water forced circulation, and direct and indirect steam plants under both vacuum and gravity methods. 1800 w. Am Soc of Heat & Vent Engrs—June, 1912. No. 34746 N.

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Estimating

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Factories

Removal of Refuse and Waste by Fans and Blowers. F. R. Still. A general description of methods successfully applied to industrial plants, and related informa-

tion. Ills. 4500 w. Am Soc of Heat & Vent Engrs—June, 1912. No. 34748 N.

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Automatic Refrigeration an Ideal Central Station Load. Porter L. Swift. Shows it to be a profitable field for the extension of electric service. 1200 w. Power—July 2, 1912. No. 34150.

Means for Accumulating Refrigeration. Charles H. Herter. Considers means available for storing up refrigeration, particularly in large storage rooms where the temperature must be kept nearly uniform. 2500 w. Power—July 30, 1912. Serial. 1st part. No. 34594.

Schools

Heating and Ventilating Park School, Rutherford, N. J. Charles A. Fuller. Plan and description. 1200 w. Power—July 23, 1912. No. 34703.

Theatres

Heating and Ventilation of the Little Theatre. Illustrates and describes methods used to furnish air for 283 persons in practically an hermetically sealed room. 800 w. Heat & Vent Mag—July, 1912. No. 34630.

Turkey

Heating in Turkey. John R. Allen. An account of business conditions, and the methods of heating. Ills. 2000 w. Am Soc of Heat & Vent Engrs—June, 1912. No. 34742 N.

Ventilation

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HYDRAULIC MACHINERY

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Hydrodynamics

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Presses

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Pumps

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Turbo-Machines

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MACHINE ELEMENTS AND DESIGN

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The Mounting of Ball Bearings. F. H. Poor. Illustrated directions. 1000 w.

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Ball Bearings in Shop Machine Construction (Das Kugellager im Werkzeugmaschinenbau). W. Vorwerck. Details the various parts of machines to which ball-bearings are applicable. Ills. Serial. 1st part. 1800 w. Zeitschr f Werkzeug—June 15, 1912. No. 34512 D.

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Valve Gears

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MACHINE WORKS AND FOUNDRIES

Accidents

Accidents in a Machine Tool Works. Luther D. Burlingame. Analysis of seven years' statistics of the plant of the Brown & Sharpe Mfg. Co. 2000 w. Ir Age—July 11, 1912. No. 34358 C.

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An Analysis of Accidents in a Machine Tool Works. Luther D. Burlingame. A study of records of accidents kept during the last seven years by the Brown & Sharpe Mfg. Co., Providence, R. I. 2000 w. Jour Am Soc of Mech Engrs—July, 1912. No. 34759 D.

Bronze Castings

Use of Chills in Making Manganese-Bronze and Other Strong Bronze Sand Castings. An explanation of the value of chills in castings and description of methods employed. Ills. 1200 w. Brass Wld—July, 1912. No. 34749.

Castings

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Casting Shells with Chilled Points and Similar Work. Walter J. May. Suggestions for such work with drawings. 1500 w. Prac Engr—June 21, 1912. No. 34211 A.

Chain Making

An Automatic Chain Welding Machine. Illustrated description. 1200 w. Ir Age—July 11, 1912. No. 34357 C.

Cores

Some Apparatus Installed for Core Testing. H. M. Lane. Illustrates and describes an experimental equipment, and gives results thus far disclosed. 1200 w. Castings—July, 1912. No. 34683.

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A Double Cutting Machine for Torpedo Propeller Blades (Doppelte Fräsmaschine für Torpedo-Schraubenflügel). F. Nickel. Description of machine cutter as designed by J. E. Reinecke, Chemnitz-Gablenz. Ills. 2400 w. Zeitschr des Ver deutschr Ing—June 8, 1912. No. 34550 D.

Dies

Hydraulic Press Dies. Illustrated description based on a hydraulic press and dies used at the Burnside shops of the Illinois Central R. R. Co. 1000 w. Boiler Maker—July, 1912. No. 34397.

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Drilling Deep Holes of Small Diameter. Illustrates and describes method of drilling holes in fairly long shaft, for lubricating purposes. 1500 w. Mech Wld—July 12, 1912. No. 34716 A.

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Foundries

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The Taylor-Boggis New Foundry at Cleveland, Ohio. Illustrated description of foundry and equipment for high grade gray iron castings. 2500 w. Castings—July, 1912. No. 34681.

The New Plant of the Rödinghausen Foundry in Menden, Westphalia (Die Neuanlage der Giesserei Rödinghausen in Menden i. W.). E. Vorbach. Illustrated description of plant and equipment. 3000 w. Stahl u Eisen—June 27, 1912. No. 34511 D.

Furnaces

Industrial Furnaces. J. B. M. Knutsen. Read before the Soc. of Chem. Ind. of Victoria. Considers their requirements, and in the present number discusses gas and oil fuel furnaces. 1500 w. Anst Min Stand—May 30, 1912. Serial. 1st part. No. 34193 B.

Natural Draft Gas Furnaces. E. P. Taudevin. Abstract of a lecture at the Glasgow & W. of Scotland Tech. Inst. Deals specially with furnaces fired with gas supplied at the normal main pressure. Ills. 1800 w. Ir & Coal Trds Rev—July 12, 1912. No. 34724 A.

The New Thin-Lined Warwick Furnace. Illustrated description of a new blast furnace. 700 w. Ir Age—July 25, 1912. No. 34766 C.

Oil Burning Frame Plate Furnace. R. D. Gatewood. Illustrates and describes details of a frame and plate-bending furnace using fuel oil. 700 w. Am Mach—July 18, 1912. No. 34491.

The Movement of the Gases in Foundry Furnaces (Die Bewegung der Gase in den hüttentechnischen Oefen). A. Roitzheim. A physical study of the heat paths in furnaces. Diagrams. Serial. 1st part. 3800 w. Stahl u Eisen—June 13, 1912. No. 34501 D.

Galvanizing

Galvanizing and Corrugating Plant and Machinery. F. W. Jackson. Briefly de-

scribes the operation and gives illustrated description of an automatic galvanizing plant. 1000 w. Prac Engr—July 11, 1912. Serial. 1st part. No. 34612 A.

Grinding

Modern Grinding Practice. H. Pearman. Discusses abrasives, their requisite properties, the bonding of grinding wheels, etc., in the present number. Ills. 4500 w. Prac Engr—July 4, 1912. Serial. 1st part. No. 34394 A.

The Rivett Internal Grinding Machine in the Automobile Factory. Chester L. Lucas. Illustrates and describes its application to various kinds of work in automobile construction. 2000 w. Mach, N Y—July, 1912. No. 34169 C.

Grinding Brass, Bronze, Aluminum and Other Non-Ferrous Alloys. From a paper by George W. Thompson, giving information of interest. 1200 w. Brass Wld—July, 1912. No. 34750.

See also Rolls, under *Machine Works* and *Foundries*.

Lathes

Some Notes on Lathes and Kindred Appliances. Irvin Haworth. Discusses methods of dealing with a variety of work. 1500 w. Mech Wld—June 28, 1912. Serial. 1st part. No. 34324 A.

Speeds of Economical Lathe Drives. A. G. Popcke. Suggestions for choosing the most suitable speed. 2000 w. Am Mach—July 18, 1912. No. 34488.

Capstan and Turret Lathes. Illustrates and describes representative types. 6000 w. Mech Wld—July 12, 1912. No. 34717 A.

See also same heading, under *Machine Elements* and *Design*.

Machine Tools

A Problem in Machine Tool Design and Its Solution. George W. Burley. States the problem and gives its mathematical solution. 600 w. Prac Engr—July 18, 1912. No. 34732 A.

Some Stresses in Machine Tool Members. H. H. Broughton. Illustrates by examples, problems in machine tool work and their solution. 1500 w. Prac Engr—July 18, 1912. No. 34731 A.

Three Old-Time Machine Tools. Illustrates and describes an old lathe and shaper with some unusual features, and an old drilling machine. 700 w. Am Mach—July 11, 1912. No. 34347.

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Pattern Plates for Molding Machine Work. Explains how they are made and gives illustrations of the various operations. 1200 w. Foundry—July, 1912. No. 34188.

Molding a 26-Ton Gray Iron Turbine Casting. Explains how economies were effected by the use of a skeleton pattern and gives details of molding and casting. 1500 w. Foundry—July, 1912. No. 34189.

Molding Sand

See Sand Tests, under *Measurement*.

Pattern Making

Trade School Pattern Making. G. S. Clarkson. An account of the methods used in teaching pattern making. 1500 w. Am Mach—July 4, 1912. No. 34202.

Patterns

See Molding, under *Machine Works and Foundries*.

Punch Presses

Manufacturing Zinc Address Plates. Etan Viall. Illustrated description of a specially built punch press for making zinc address plates for mailing machines. 2500 w. Am Mach—July 18, 1912. No. 34487.

Radiator Making

Spiral and Flat Tube Radiator Work. Illustrated detailed description of an automatic machine for this work. 2000 w. Am Mech—July 25, 1912. No. 34741.

Rolls

Grinding and Corrugating Flour Mill Rolls. F. B. Jacobs. Illustrates and describes the work and machines used. 800 w. Mach, N Y—July, 1912. No. 34158 C.

Safety Devices

Safeguarding Factory Tools and Equipment. D. C. Pultney. Remarks on the application of safeguards, illustrating and describing some of the devices. 1500 w. Elec Jour—July, 1912. No. 34838.

Wire Mesh Guards for Machinery. Gives valuable suggestions for the application of safeguarding devices. Ills. 1300 w. Ir Age—July 25, 1912. No. 34765 C.

Oliver Iron Mining Co.'s Shops at Hibbing, Minn. Illustrates and describes methods of safeguarding equipment to prevent accidents. 3000 w. Ir Tr Rev—July 11, 1912. No. 34387.

Screws

Taps and Screws. F. O. Wells and H. E. Harris. Also discussion. Presents some of the problems of tap and die making. Ills. 7800 w. Jour Am Soc of Mech Engrs—July, 1912. No. 34761 D.

Sheet-Metal Work

A Few Sheet-Metal Forming Methods. Joseph M. Stabel. Gives rules for getting the radius of right angle bends and the length of blanks and diagrams of dies. 1200 w. Am Mech—July 11, 1912. No. 34348.

Shop Equipment

The Care of Machinery. G. D. Ottaway. Suggestions for the up-keep of shop equipment. 1000 w. Elec Jour—July, 1912. No. 34844.

Shop Practice

Laps for Cylindrical Surfaces. Illustrates and describes a system of laps which gives long service. 800 w. Am Mech—July 18, 1912. No. 34489.

Machinery Iron-Bodied Valves. Illustrates and describes methods employed in making large iron safety valves. 1000 w. Am Mach—July 25, 1912. No. 34739.

Jig Work in a Shoe Machinery Plant. F. A. Stanley. Illustrates and describes work in the machine shop of the United Shoe Machinery Co. 3500 w. Am Mach—July 25, 1912. No. 34737.

Making Automatic Sprinkler Heads. Fred H. Colvin. Illustrates and describes methods employed and punch press and screw-machine kinks. 2000 w. Am Mach—July 11, 1912. No. 34345.

Making "Cygnet" Phonograph Horns. Illustrates and describes tools and methods used. 1500 w. Am Mach—July 18, 1912. No. 34490.

Making the "Universal" Hack-Saw Blade. Chester L. Lucas. Illustrated detailed description. 800 w. Mach, N Y—July, 1912. No. 34165 C.

Watch Case Manufacture. Illustrates and describes types and methods. 1800 w. Mach, N Y—July, 1912. Serial. 1st part. No. 34159 C.

Manufacturing a Shoe Machine Head. F. A. Stanley. Illustrates and describes details of tools employed and particulars of the inspector's gages for testing the accuracy. 1200 w. Am Mach—July 11, 1912. No. 34342.

Operations in a Printing Press Shop. Glenn Muffy. Illustrates and describes all the important shop operations in handling the work. 1200 w. Am Mach—July 4, 1912. No. 34200.

Shops

The American Bridge Company's Gary Shops. Illustrated description of shops aiming to provide the best possible handling facilities. 2500 w. Ir Age—July 4, 1912. No. 34249 C.

The Bridge and Structural Shops of the American Bridge Company at Gary. Illustrated description of the buildings, tools, and methods of work for shop units with an annual capacity of 120,000 tons. 3000 w. Eng Rec—June 29, 1912. No. 34116.

The Esslingen Machine Shops at Esslingen (Die Maschinenfabrik Esslingen in Esslingen). Alfred Widmaier. Illustrated description of these locomotive shops. 9600 w. Zeitschr des Ver deutscher Ing—June 8, 1912. No. 34548 D.

The Clock Factory of the Junghaus Bros., Schramberg (Die Uhrenfabriken von Gebrüder Junghaus A.-G., Schramberg). Alfred Widmaier. Illustrated description of this plant. 3500 w. Zeitschr. des Ver deutscher Ing—June 15, 1912. No. 34552 D.

The Robert Bosch Electrical Manufactory in Stuttgart (Die elektrotechnische Fabrik von Robert Bosch in Stuttgart). Alfred Widmaier. Description of plant and some of the apparatus turned out by it. Ills. 7000 w. Zeitschr des Ver deutscher Ing—June 22, 1912. No. 34555 D.

The Plant of the Daimler Motor Company at Stuttgart-Untertürkheim (Die

Fabrik der Daimler-Motoren-Gesellschaft in Stuttgart-Untertürkheim). Robert Uhl-land. Description of this plant and some of its work. Ills. 3000 w. Zeitschr des Ver deutscher Ing—June 22, 1912. No. 34554 D.

See also same heading, under RAILWAY ENGINEERING, *Motive Power and Equip-ment*; also under STREET AND ELECTRIC RAILWAYS.

Special Tools

Milling Fixtures of Various Types. Lucian L. Haas. Gives points for consideration in the design of special tools for a given piece of work, the operation of cutters and the application of gages, etc. Ills. 2500 w. Am Mach—July 4, 1912. No. 34198.

A Few Shipyard Machines and Devices. Ethan Viall. Illustrates and describes special machines for various kinds of work. 1000 w. Am Mach—July 11, 1912. No. 34344.

Taps

See Screws, under *Machine Works and Foundries*.

Tools

Manufacturing a Lapel Button-Back. F. A. Stanley. Illustrates and describes the tools used in producing this device. 4000 w. Am Mach—July 4, 1912. No. 34199.

Tubes

Mannesman Seamless Steel Joint Tubes. Illustrates and describes the earlier and later methods employed in their production. 1000 w. Ir Age—July 18, 1912. No. 34638 C.

MATERIALS OF CONSTRUCTION

Alloys

Handling the Copper-Tin Alloys in the Brass Foundry. H. Kloss, in *Giesserei Zeit*. Considers the influence of tin on the properties of the bronze. 1200 w. Castings—July, 1912. No. 34682.

Lubricants

The Effect of Added Fatty and Other Oils Upon the Carbonization of Mineral Lubricating Oils. C. E. Waters. Reports of investigations. 14 pages. Tech Papers of Bureau of Stand, No. 4—Aug. 24, 1911. No. 34496 N.

See also Lubricant Testing, under *Measurement*.

Pig Iron

The Possibilities of Special Foundry Pig Iron. Herbert Pilkington. Read before the British Found. Assn. Discusses methods favored abroad for obtaining certain desirable qualities in cast iron. 2000 w. Castings—July, 1912. No. 34684.

Rubber

Rubber, Natural and Synthetic. Prof. F. Willy Hinrichsen. Discusses the commercial possibilities of artificial rubber. 2000 w. Sci Am—July 20, 1912. No. 34653.

Synthetic Rubber. C. J. Beaver. Discusses recent advances made in the production of synthetic rubber and its com-

mercial possibilities. 1500 w. Elect'n, Lond—July 12, 1912. No. 34707 A.

Steel

Influence of Heat on Hardened Steel. Edward G. Herbert. Gives details of experiments to determine the effect of different temperatures on carbon and high-speed steels. 6000 w. Am Mach—July 11, 1912. No. 34343.

Determination of Carbon in Steel. W. L. Morrison. Explains a rapid method based upon the direct combustion of the sample in an electric furnace, and the absorption of the CO₂ in a bulb resting on a scale pan. Ills. 1000 w. Eng & Min Jour—June 29, 1912. No. 34130.

The Determination of Chromium and Its Separation from Vanadium in Steels. J. R. Cain. Describes the method, giving notes and precautions. 1500 w. Tech Papers of Bureau of Stand, No. 6—Nov. 1, 1911. No. 34498 N.

Problems of the Factory Metallurgist. William D. Mainwaring. From a paper before the Soc. of Detroit Chemists. Deals with problems arising in works practice in connection with the metallurgy of steel, and the methods used in solving them. Ills. 3000 w. Ir Age—July 25, 1912. No. 34767 C.

Tool Steels

High Speed Tool Steels. Irvin Haworth. Considers the effect of carbon on iron, the addition of rare metals, hardening and tempering. 2500 w. Prac Engr—July 11, 1912. No. 34613 A.

MEASUREMENT

Colorimeters

The Quality of Steam in Boilers. O. Z. Howard. How to make a calorimeter from pieces of pipe and standard fittings, and method of figuring the quality of the steam. 1200 w. Power—July 9, 1912. No. 34304.

Equivalents

Horsepower and Kilowatts. F. R. Low. Gives a table of equivalents at various efficiencies, with notes. 1000 w. Power—July 9, 1912. No. 34303.

See also Units of Energy, under *Measurement*.

Force Relations

Static and Dynamic Force Relations in Machines. Walter Rautenstrauch. Explains method for determining the dynamic relations in machines. Diagrams. 2500 w. Sch of Mines Qr—July, 1912. No. 34621 D.

Laboratory

The British Physical Laboratory. I. W. Chubb. Explains the purpose of the laboratory and describes the work. Ills. 6000 w. Am Mach—July 4, 1912. No. 34197.

Lubricant Testing

Machine for Testing Lubricants. Illustrates and describes the Sternol patent oil-testing machine and its work. 2500 w. Engng—June 28, 1912. No. 34333 A.

Pipe Friction

Formula and Constants for Friction Loss in Dredge Discharge Pipes. H. Berridge. Gives diagrams and calculations for determining constants in Unwin's exponential formula from observations on friction loss in discharge pipes of Mississippi dredges. 1000 w. Eng News—July 18, 1912. No. 34650.

Friction Formulas for Commercial Pipe. Ira N. Evans. Compares results of standard formulæ in curves and tables, with notes. 2500 w. Power—July 9, 1912. No. 34305.

Pyrometers

Calibration of Radiation Pyrometers. G. A. Shook. An explanation of methods used, giving details of various types. 3000 w. Met & Chem Engng—July, 1912. No. 34174 C.

Sand Tests

Molding Sand Tests. Report of investigations by the Am. Found Assn. of 92 Sands, including Mineral Characteristics, by D. Dole Condit; the Microscope as a Testing Medium, by H. C. Loudenbeck, and other information. 5 parts. 8000 w. Am Found Assn—Vol. XXI. No. 34377 N.

Testing Machines

Combination Forming and Testing Machine. F. B. Hays. Brief illustrated description of the machine and its operation. 500 w. Mach, N Y—July, 1912. No. 34160 C.

Testing Metals

Recent Methods for Mechanical Tests of Metals (*Étude sur les nouvelles méthodes d'essais Mécaniques des métaux*). M. R. Guillery. General review of recent methods, and more particularly the Brinell tests. Ills. and plates. 8800 w. Mem Soc Ing Civ de France—March, 1912. No. 34564 G.

Torsion

A General Formula for the Torsional Deflection of Shafts. S. E. Slocum. Derives a general formula for torsional deflection. 800 w. Jour Fr Inst—July, 1912. No. 34628 D.

Units of Energy

Simplifying Some Engineering Calculations. Carl Hering. Refers to the general principle urged in earlier papers, and considers the application of this simplified system to water and steam power calculations. 3000 w. Eng News—July 11, 1912. No. 34403.

POWER AND TRANSMISSION**Air Compressors**

Modern High - Power Compressors (*Moderne Hochdruckkompressoren*). Kl. Karger. A review of present practice in design to meet the various classes of work to be performed. Ills. Serial. 1st part. 2200 w. Zeit d. Oest Ing u. Arch Ver—June 28, 1912. No. 34547 D.

Compressed Air

Explosion of Air Receiver Due to Oil. Frank Richards. Explains the cause of

an explosion of a small air receiver in Brooklyn on June 24. 1200 w. Power—July 30, 1912. No. 34593.

See also Tunnels, under CIVIL ENGINEERING, *Construction*.

Electric Power

Electric Driving in a Keighley Mill. Illustrates and describes modern examples of electrical individual and group driving. 1000 w. Elec Rev, Lond—June 21, 1912. No. 34207 A.

See also Electric Drive, under ELECTRICAL ENGINEERING, *Power Applications*; and Electric Power, under MINING AND METALLURGY, *Iron and Steel*.

Power Comparisons

A Comparison of Gas and Electric Power for Drawbridge Swinging. Also editorial. Gives results of tests made at the swing span at Black Rock, N. Y. 1200 w. Eng News—July 18, 1912. No. 34644.

Power and Industrial Work. G. A. Julius. Considers the forms of drive most common in factory practice and analyzes the advantages and disadvantages of various powers from an engineering and commercial standpoint. 3500 w. Aust Min Stand—June 6, 1912. No. 34482 B.

Power Machinery

Power Machinery of the Steel Industry. Robert L. Streeter. First of a series of articles reviewing steam, electric, and gas motors applied to the operation of American furnaces and mills. Ills. 3000 w. Engineering Magazine—Aug., 1912. No. 34753 B.

Power Plants

Old English Power Plants. John S. Leese. Illustrates and describes some old engines and boilers which have passed the century mark. 1000 w. Power—July 23, 1912. No. 34698.

Pulleys

See same heading, under *Machine Elements and Design*.

Tidal Power

Deriving Power from Flood and Ebb (*Die Ausnutzung der Kraft von Flut und Ebbe*). Adolf Springe. Describes a projected plant near Husum, in which power is generated from impounded flood tides. Ills. and maps. Serial. 1st part. 3000 w. Zeit f d ges Turbinenwesen—June 20, 1912. No. 34537 D.

Turbo-Blowers

Construction and Operation of Turbo-Blowers and Compressors. Franz zur Nedden. This second article of a series considers temperature effects and cooling devices. Ills. 1500 w. Engineering Magazine—Aug., 1912. No. 34754 B.

Turbo Compressors

Use of Turbo Compressors in the Mining Field. George E. Edwards. An account of recent installations in the United States. Ills. 3500 w. Min & Engng Wld—July 6, 1912. No. 34290.

STEAM ENGINEERING

Boiler Efficiency

Limiting Efficiencies of Steam Plants. R. C. H. Heck. Considers the influence of feed-water temperature upon absolute efficiency and gives calculations showing the best efficiency attainable. 2200 w. Power—July 2, 1912. No. 34146.

Boiler Flues

An Ideal Boiler Tube Department. L. R. Pomeroy. Illustrated outline of a flue department handling 450 tubes a day, at a labor cost not to exceed three cents per tube. 2000 w. Am Engr—July, 1912. No. 34263 C.

Boiler House

The Boiler House Plant of the Royal Liver Buildings, Liverpool. Illustrated detailed description. 1200 w. Engr, Lond—July 19, 1912. No. 34902 A.

Boiler Rating

Heating Surface, Boiler Horsepower. F. L. Johnson. Gives tables and instructions for using them in computing the heating surface and rated horse-power. 1200 w. Power—July 2, 1912. No. 34148.

See also Engine Rating, under *Steam Engineering*.

Boiler Tests

Chart for Calculating Boiler Tests. F. O. Pahmeyer. Gives chart for calculating results and explains its use. 1000 w. Power—July 23, 1912. No. 34700.

Coal Purchases

Government Coal Purchases Under Specifications, with Analyses for the Fiscal Year 1909-1910. George S. Pope. With a Chapter on the Fuel Inspection Laboratory of the Bureau of Mines, by Joseph D. Davis. 91 pages. U S Bureau of Mines—Bul 41. No. 34372 N.

Condensers

Safe Operation of Jet Condensers. John S. Leese. Explanations and suggestions for safe operation. 1000 w. Prac Engr—July 4, 1912. Serial. 1st part. No. 34393 A.

Economizers

Heat Transmission Through Conducting Surfaces. Discusses the present tendency of reducing the heat conducting surface per h. p. in boilers. Ills. 1500 w. Met & Chem Engng—July, 1912. No. 34179 C.

Steam Boiler Efficiency and Most Economical Method for Absorbing Heat from Gases of Combustion. Explains the saving by using economizers. Ills. 1500 w. Ind Engng—July, 1912. No. 34769 C.

Engine Compression

Compression in Engine Cylinders. W. J. Attick. Shows that under certain conditions compression is valuable as a means of regulating the ratio of expansion and inducing quiet running. 3000 w. Power—July 30, 1912. No. 34591.

Engine Rating

Nominal Horse-Power of Engines. James Shirra. Read before the Engng.

Assn. of N. S. W. A discussion of the origin, meaning and value of the term. 2500 w. Aust Min Stand—May 30, 1912. Serial. 1st part. No. 34192 B.

Engine Testing

Testing an Engine Under Difficulties. H. B. Lange. Brief description of methods followed to make sure only the correct quantity of water should be charged to an engine being tested for steam consumption. 2400 w. Power—July 2, 1912. No. 34149.

Evaporators

Heat Transmission in Vacuum Evaporator Tubes. Harry M'Cormack, H. C. Dormitzer, and E. P. Roleson. An account of experiments made to determine the efficiencies of a Swenson evaporator using tubes of four different materials—copper, steel, lead and tin. 3300 w. Chem Engr—July, 1912. No. 34876 C.

Feed Water

Electrolytic Treatment of Water. D. van Arsdale. From a report by H. W. Cutshall, describing a plant for purifying boiler feed-water on the E. P. & S. R. R. 1200 w. Eng & Min Jour—July 13, 1912. No. 34426.

Bleeding Steam from Receivers of Triple Expansion Engines for Heating Feed Water. George M. Peck. Report of investigation carried out at the St. Louis water works. Plan. 1200 w. Eng News—July 18, 1912. No. 34648.

Flue-Gas Analysis

Combustion and Flue Gas Analysis. Charles M. Rogers. Brief outline showing theoretical relation between percentage of CO₂ and boiler efficiency. 1500 w. Power—July 2, 1912. No. 34147.

Smoke Prevention

See Smoke, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Stacks

Furnace Leader and Stack Proportions. E. M. Shealy. Discussion on relative carrying capacities of round and rectangular pipes and easy method of proportioning leaders and stacks. 3000 w. Met Work—July 19, 1912. No. 34634.

Chimneys and Chimney Draught. Considers chimneys where the draught is of importance. 1700 w. Prac Engr—June 28, 1912. No. 34316 A.

Steam Tables

Low Pressure Steam Tables. Lionel S. Marks. Gives tables of the properties of dry and saturated steam at pressures below that of the atmosphere. 3000 w. Power—July 16, 1912. No. 34453.

Superheating

Duchesne's Experiments on Superheat. V. Dwelshauvers-Dery. Reviews the findings of an experimental study by Monsieur Duchesne. 3500 w. Power—July 23, 1912. No. 34699.

Economy Due to Superheated Steam in Marine Practice. Walter M. McFarland. Reports the performance of a number of

vessels fitted with superheaters, and calls attention to some drawbacks to their satisfactory use. 3000 w. *Int Marine Engng*—July, 1912. No. 34156 C.

Thermodynamics

The Second Law of Thermodynamics and the "Death" of Energy, with Notes on the Thermodynamics of the Atmosphere. Charles P. Steinmetz. The law that "without expenditure of some other kind of energy heat flows only from higher to lower temperatures," is discussed and its limitations shown. 4000 w. *Gen Elec Rev*—July, 1912. No. 34225 C.

The True Second Law of Thermodynamics. Jacob T. Wainwright. Editorial letter giving results of experimental investigation. 1400 w. *Engr*, Lond—June 21, 1912. No. 34354 A.

Turbine Design

The Steam-Turbine Expansion Line on the Mollier Diagram, and a Short Method of Finding the Reheat Factor. Edgar Buckingham. Explains the important properties of quantities of the Mollier diagram, discusses the form of the expansion line for wet steam flowing through a multi-stage turbine and develops a method for drawing the expansion line. 617 pps. Bureau of Stand—Report No. 167. No. 34799 N.

Turbine Economy

Improvement in the Output of Steam Turbines with the Use of Disc Escapements (*L'Amélioration du rendement des Turbines à vapeur par l'emploi des "Disques d'échappement"*). M. Delaporte. Statements on the recent improved results in turbine economy from this cause. Ills. 3000 w. *Rev de Méc*—June 30, 1912. No. 34573 E + F.

The Production of Higher Vacuum in Steam Turbines with Small Exhaust Sections (*Die Ausnutzung hoher Luftleere in Dampfturbinen bei kleinen Austrittquerschnitten*). F. Lösel. Discussion on the phenomenon attending experimental tests in producing 90 per cent vacuum. Ills. 5000 w. *Zeitschr des Ver deutscher Ing*—June 22, 1912. No. 34556 D.

Turbine Operation

Methods of Operating Mixed Pressure Turbines with Engines Driving Mechanical Loads. R. C. Muir. Describes two methods of regulating or load balancing between the turbine and the engine, which may be employed when high economy is of importance. 1500 w. *Gen Elec Rev*—July, 1912. No. 34227 C.

Mixed Pressure Turbine Installation of the Tennessee Coal, Iron & R. R. Co. E. J. Best. Illustrated detailed description of the new power house and its equipment. 2200 w. *Gen Elec Rev*—July, 1912. No. 34228 C.

A Mixed Pressure Turbine Installation on Traction Service. E. G. Morgan. Gives a typical example where great increase in station capacity has been ob-

tained without any increase in boiler equipment. 1200 w. *Gen Elec Rev*—July, 1912. No. 34229 C.

A Mixed-Pressure Turbine Installation at a Steel Works. B. E. Semple. Describes a 7,000 k. w. mixed-pressure Curtis turbine installed at the plant of a large steel manufacturing corporation. Ills. 1800 w. *Gen Elec Rev*—July, 1912. No. 34230 C.

Turbines

Exhaust Steam Turbine at Republic Mine, Mich. George E. Edwards. Brief illustrated description of this plant. 700 w. *Min & Engng Wld*—June 29, 1912. No. 34138.

Large Steam Turbine Development. A discussion of the present development of large steam turbine construction and of the field of the steam turbine both in this country and in Europe. Ills. 3000 w. *Power*—July 30, 1912. No. 34592.

The Ljungström Steam Turbine (*Die Ljungström-Dampfmaschine*). Illustrated description of the main features in this type. Serial. 1st part. 1500 w. *Die Turbine*—June 5, 1912. No. 34535 D.

Notes on Steam Turbines (*Note sur les Turbines à Vapeur*). A. R. Garnier. Mathematical discussion on the effective energy of steam in turbines. Diagrams. 5000 w. *Rev de Méc*—June 30, 1912. No. 34574 E + F.

TRANSPORTING AND CONVEYING

Ash Handling

The Mechanical Disposal of Ashes from Steamers. J. F. Zimmer. Illustrates and describes apparatus for avoiding dirt and lessening labor. 4000 w. *Cassier's Mag*—July, 1912. No. 34908 B.

Cableways

The Evolution of the Cableway. Henry M. Payne. Notes six stages in the evolution. Ills. 1400 w. *Eng & Min Jour*—June 29, 1912. No. 34128.

Conveyor Belts

Wear of Conveyor Belts. Reginald Trautschold. Gives an analysis of the causes and means for their reduction. 3000 w. *Ir Age*—July 4, 1912. No. 34250 C.

Conveyors

Some Notes on Band Conveyors. F. Tissington. First of a series of articles showing their many uses, adaptability and arrangement for various duties. 2000 w. *Can Engr*—July 11, 1912. Serial. 1st part. No. 34484.

Elevators

The Power Requirements of Electric and Hydraulic Hoists (*Der Kraftverbrauch von elektrischen und hydraulischen Hebezeugen*). P. Eilert. Discussion on relative costs in the operation and installation of these systems. Ills. 4800 w. *Zeitschr des Ver deutscher Ing*—July 6, 1912. No. 34559 D.

See also Grain Elevators, under *Transporting and Conveying*.

Freight Handling

The Mechanical Handling of Freight. Discussion of the paper by Samuel B. Fowler presented previously. Ills. 10000 w. Jour Am Soc of Mech Engrs—July, 1912. No. 34762 D.

Grain Elevators

Central-Station Power for Grain Elevators. Gives results obtained in numerous plants and the advantages of motor drive in this field. Ills. 3500 w. Elec Rev & W Elect'n—June 29, 1912. No. 34139.

Ore Handling

Conveying Ore to Vessels in Inaccessible Coasts. C. A. Tupper. Illustrates and describes plants constructed to meet such conditions. 3000 w. Min & Engng Wld—July 20, 1912. No. 34686.

MISCELLANY**Gas By-Products**

By-Products in Gas Manufacture. Charles E. Munroe. An interesting illustrated study of this industry and the by-products—coke, gas, carbon, tar, ammoniacal liquor and spent purifying material, either lime or oxides and related matters. 7800 w. Jour Fr. Inst. July, 1912. No. 34626 D.

Optics

Presidential Address at the Optical

Convention. Silvanus P. Thompson. Reviews the development, the theories, and work of prominent investigators, optical instruments, etc. 12000 w. Engng—June 28, 1912. No. 34334 A.

Paper Manufacturing

Growth and Present Operation of the J. M. Voith Factory at Heidenheim-on-the-Brenz (Die Entwicklung und die neuzeitlichen Leistungen der Maschinenfabrik von J. M. Voith in Heidenheim a. d. Brenz). Illustrated description of this paper manufactory and its mechanical installations. Plates. 7000 w. Zeitschr des Ver deutscher Ing—June 8, 1912. No. 34549 D.

Textile Industry

The Württemberg Textile and Paper Industry (Die württembergische Textil- und Papierindustrie). Otto Johannsen. Outline of the growth and development of these industries, and present importance, with description of plants. Ills. 9500 w. Zeitschr des Ver deutscher Ing—June 15, 1912. No. 34551 D.

Vacuum Cleaners

Notes on Vacuum Cleaners. Discusses portable vacuum stationary cleaners, types of pumps, driving motors, and related subjects. 2500 w. Elec Rev, Lond—July 19, 1912. No. 34598 A.

MINING AND METALLURGY**COAL AND COKE****Alberta**

The Coalfields of Alberta. E. H. Cunningham Craig. Information concerning these extensive deposits and the quality of the coal. 1200 w. Min Jour—June 29, 1912. No. 34813 A.

Alaska

Geography in the Development of Alaskan Coal. Alfred H. Brooks. Reprint of a paper read before the Assn. of Am. Geog. Discusses the principles which govern the economics of mineral fuel supply and applies them to the Alaska coal fields. Map. 3500 w. Min & Engng Wld—July 27, 1912. No. 34873.

Analysis

The Constituents of Coal Soluble in Phenol. J. C. W. Frazer and E. J. Hoffman. An investigation to obtain information regarding the composition of coal and the nature of its constituents. 4000 w. U S Bureau of Mines—Tech paper No. 5. No. 34614 N.

The X-Ray Examination of Coal. Gives radiographs supplied by M. Henri Couriot, with descriptive matter. 800 w. Col Guard—July 5, 1912. No. 34470 A.

Briquettes

A Promising Industry. Guy E. Mitchell. Gives statistics of American fuel bri-

quette manufacture. 2000 w. Sci Am Sup—July 20 1912. No. 34654.

British Columbia

Notes on the Groundhog Coal Basin, Skeena District, B. C. G. S. Malloch. Information concerning the location, geology, character of the coal and transportation facilities. 800 w. Trans Can Min Inst—Vol. XV. Part I. No. 34380 N.

Coal-Cutters

A Rope-Driven Coal-Cutter. Wilfred L. Spence. Read before the Inst. of Mine Engrs. Illustrated description of a wire-rope driven coal-cutter, its operation, advantages, etc. 4500 w. Mech Engr—June 28, 1912. No. 34322 A.

Coal Storage

The Storage of Coal and Spontaneous Combustion. Horace C. Porter. Read before the Pittsburgh section of the Am. Chem. Soc. Discusses losses from weathering and heating. 3500 w. Cassier's Mag—July, 1912. No. 34912 B.

Coke-Oven Gas

See Nitrogen, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Coking

A Laboratory Method for the Comparison of the Coking Properties of Coal. R. Lessing. Read before the Inst. of Gas Engrs. Accounts of experiments. Ills.

3000 w. Col Guard—June 28, 1912. No. 34328 A.

Competition

International Coal Competition. Allan Greenwell. A discussion of international coal trade, giving statistics. 4500 w. Trans Can Min Inst—Vol. XV., Part I. No. 34383 N.

Explosions

Earthquakes, Strains and Stresses in Relation to Colliery Explosions. F. Napier Denison. Supplementary to an earlier paper, recording additional information. 1200 w. Trans Can Min Inst—Vol. XV. Part I. No. 34381 N.

History of Coal-Dust Explosions. Eugene B. Wilson. An abridged account showing the probable causes and suggesting remedies. 11500 w. Mines & Min—July, 1912. No. 34180 C.

Accidents from Explosives in 1911. From the report of H. M. inspectors of explosives for the year 1911. 2500 w. Col Guard—June 28, 1912. No. 34330 A.

Germany

Germany's Anthracite Export and Its Significance in the Various Mine Reviews of the Country (Die Steinkohlenausfuhr und ihre Bedeutung für die verschiedenen Bergbaureviere des Landes). Ernst Jüngst. A study of the coal export trade of the country. 4900 w. Glückauf—June 15, 1912. No. 34508 D.

Great Britain

Geological Research in the Coalfields. Information from the Summary of Progress of the Geological Survey for 1911. 4000 w. Col Guard—July 19, 1912. Serial. 1st part. No. 34892 A.

Geological Survey of the Midland Coalfield. Information concerning the Staffordshire and Warwickshire coalfields. 3000 w. Ir & Coal Trds Rev—July 12, 1912. No. 34725 A.

Geological Survey of the Scottish Coalfield. Information from the "Summary of Progress of the Geological Survey of Great Britain." The coalfields were grouped in two districts, and each is described. 4000 w. Ir & Coal Trds Rev—July 12, 1912. No. 34723 A.

Japan

Japanese Coal-Mining Industry. Information from a recent Consular report concerning the coal-mining industry of the Hokkaido, and the country generally. 1500 w. Ir & Coal Trds Rev—July 19, 1912. No. 34906 A.

Manchuria

The Coal Supply of Manchuria. Edward di Villa. Information concerning the coal deposits and the mines already worked. 800 w. Min & Sci Pr—July 13, 1912. No. 34605.

Mine Gases

Physiological Effects of Carbon Monoxide. Henry S. Munroe. Information concerning the dangerous nature of this

gas. 1600 w. Sch of Mines Qr—July, 1912. No. 34620 D.

New Zealand

Coal Mining in New Zealand. Extracts from the report of the Royal Commission appointed to investigate safety and health in mining. 2500 w. Col Guard—June 28, 1912. Serial. 1st part. No. 34329 A.

Spitzbergen

Coal and Coal-Mining in Spitzbergen. A. Udhaug. Illustrated account of these islands north of Norway, and a discussion of the coal-producing prospects. 1800 w. Ir & Coal Trds Rev—June 28, 1912. No. 34340 A.

Trade

Fuel Problems of the Pacific. H. Foster Bain. A statement of conditions and discussion of the outlook for the coal trade after the opening of the Panama Canal. 5000 w. Trans Can Min Inst—Vol. XV. Part I. No. 34384 N.

United States

Coal Resources of the United States. Edward W. Parker. Map and discussion of the coal areas. 1500 w. Trans Can Min Inst—Vol. XV. Part I. No. 34382 N.

Ventilation

The Direct Driving of Mining Plant by Internal-Combustion Engines. A. Vennell Coster. Discusses especially the direct driving of colliery fans. Ills. 3000 w. Cassier's Mag—July, 1912. No. 34910 B.

Modern Ventilating Machines. W. Charlton. Read before the S. Staff. and Warwickshire Inst. of Min. Engrs. Illustrates and describes changes introduced in colliery fans, describing modern types. Discussion: 5000 w. Ir & Coal Trds Rev—June 21, 1912. No. 34223 A.

Washing

"Dortmund" Washery at the Holbrook Colliery. Illustrated detailed description. Plate. 2000 w. Ir & Coal Trds Rev—July 5, 1912. No. 34478 A.

Modern Coal Washing Practice (Moderne Kohlenschlammgewinnung). Th. Möhrle. Description of some of the apparatus employed in the washing and sorting of coal. Ills. Serial. 1st part. 1000 w. Oest Zeit f Berg u Hutten—June 22, 1912. No. 34503 D.

COPPER

Germany

Copper Occurrence in Lower Glindetale near Niedermarsberg, Westphalia (Das Kupfererzvorkommen im untern Glindetale bei Niedermarsberg in Westfalen). K. Boden. Description of the field and character of the ore. Diagrams. Serial. 1st part. 5600 w. Glückauf—June 15, 1912. No. 34506 D.

Lake Superior

Copper Mining at Lake Superior. Claude T. Rice. Describes the deposits and the mining methods. Ills. 5000 w. Eng & Min Jour—July 20, 1912. Serial. 1st part. No. 34673.

Ontario

Origin of the Sudbury Nickel and Copper Deposits. Reginald E. Hore. An illustrated study of those sulphide deposits in Ontario, Canada, giving opinions of various investigators. 3500 w. *Min & Engng Wld*—June 29, 1912. No. 34135.

Quebec

The Copper Deposits of Eastern Quebec. John E. Hardman. Reviews the history of the industry, describing the deposits and showing that large capital is required to make their development profitable. 2000 w. *Can Min Jour*—July 1, 1912. No. 34270.

Ural Mountains

Copper Mines in the Urals. E. de Hauptick. A general account of the mines and their development. 1800 w. *Min Jour*—July 6, 1912. No. 34463 A.

GOLD AND SILVER**Alloy Assaying**

The Solubility of Nitric Acid of Gold Contained in Certain Copper-Alloys (Copper Bullions). Edward Keller. Considers the chemical composition of auriferous copper-bullions, describing their treatment in sampling and assaying and discussing experiments and theories. 3500 w. *Bull Inst of Min Engrs*—July, 1912. No. 34846 F.

Arizona

The La Fortuna Mine. F. J. Martin. An account of the discovery and early development of this Arizona property. 1500 w. *Min & Sci Pr*—July 6, 1912. No. 34352.

California

Forbestown District, California. Lewis H. Eddy. An account of a gold and silver district which produced for 18 years and was then abandoned for various reasons. 4000 w. *Eng & Min Jour*—July 27, 1912. No. 34814.

Colombia

El Porvenir Mine in the District of Mallama. F. P. Gamba. Map with description of the ore deposits as found therein. 1800 w. *Min & Sci Pr*—July 13, 1912. No. 34602.

Cyaniding

The Parks Electro-Cyanide Process. John R. Parks. Describes the process and reports concerning its efficiency. Ills. 2500 w. *Sch of Mines Qr*—July, 1912. No. 34623 D.

Cyanidation of Antimonial Tailings, N. S. W. W. Archer Longbottom. Explains the difficulties of the problem and describes the equipment and method of working. 1700 w. *Min & Engng Wld*—July 20, 1912. No. 34687.

Dredging

Gold Dredging Up to Date. Arthur Lakes. Reviews the history of dredging in America, giving costs and conditions in various regions. Ills. 4000 w. *Mines & Min*—July, 1912. No. 34181 C.

Idaho

Gold Deposits of Gibbonsville, Idaho. Francis Church Lincoln. Describes the topography, geology and ore deposits. 2000 w. *Min & Sci Pr*—July 13, 1912. No. 34603.

Low-Grade

Economic Mining of Low-Grade Gravel, California. A. H. Martin. Describes practice in mining low-grade auriferous gravel. 1500 w. *Min & Engng Wld*—July 13, 1912. No. 34447.

Mexico

Mining in the Morelos District. G. L. Sheldon. Describes these silver mines in Mexico, reviewing briefly their history. Map. 1500 w. *Min & Sci Pr*—June 29, 1912. No. 34238.

Veta Colorada Mill and Cyanidation Plant. Bernard MacDonald. Illustrates and describes this plant in Mexico, its construction, design, and equipment. 3000 w. *Min & Sci Pr*—July 6, 1912. Serial. 1st part. No. 34351.

Nevada

Mineral Hill, Nevada. R. H. Toll. Map and description of high-grade silver mines. 2000 w. *Min & Sci Pr*—June 29, 1912. No. 34239.

Placers

See Placer Concentrators, under *Ore Dressing and Concentration*.

Quebec

A Brief Historical Sketch of Gold and Copper Mining in Quebec. Dr. James Douglas. A review. 1000 w. *Can Min Jour*—July 1, 1912. No. 34266.

Rand

First Impressions of the Rand. Edgar A. Collins. Mentions troubles that impressed the writer as to the position of the mine engineer and especially the mine manager. Ills. 2500 w. *Min & Sci Pr*—June 29, 1912. No. 34237.

The "New Metallurgy." H. Stadler. An account of present and former conditions at the East Rand Proprietary mines. 3000 w. *Mines & Min*—July, 1912. No. 34185 C.

Benoni Mine and Mill on the Rand. H. S. Gieser. Illustrated description of these gold mines and methods of working. 3000 w. *Eng & Min Jour*—July 6, 1912. No. 34273.

Siberia

Electrical Installations of the Lena Gold Mining Company. Describes electrical installations in Siberia for generating power for the mines. Ills. 2000 w. *Min Jour*—June 29, 1912. No. 34314 A.

Washington

The Development of the Republic District, Wash. Sidney Norman. Reviews the history of these gold and silver mines, and describes the present condition and needs of the camp for further development. Ills. 2500 w. *Min & Engng Wld*—July 6, 1912. No. 34291.

IRON AND STEEL

Blast-Furnaces

Direct and Indirect Reduction in the Blast Furnace. M. Levin. An explanation, illustrated by examples. 2000 w. *Met & Chem Engng*—July, 1912. No. 34175 C.

Dry Blast

A New Dry Blast Process for Iron Furnaces. John B. Miles. Describes the process employed at Standish, N. Y., which differs in essentials from other processes tried. 1500 w. *Mech Engr*—July 19, 1912. No. 34890 A.

Electric Power

The Utilization of Electric Power for Iron Mining. Illustrated description of developments of the Cleveland Cliffs Iron Co. on the Marquette Range, and of the Carp River hydro-electric project. 3500 w. *Ir Trd Rev*—July 25, 1912. Serial. 1st part. No. 34784.

The Electrically Operated Loftus Ironstone Mine. Illustrated description of an example of mine electrification in Great Britain. 1500 w. *Sci Am Sup*—July 20, 1912. No. 34656.

Electrometallurgy

Electric Furnace Pig Iron at Trollhättan. Information from a recent report of progress. Ills. 1500 w. *Met & Chem Engng*—July, 1912. No. 34173 C.

The Production of Pig-Iron in the Electric Furnace. Trans. from *Le Génie Civil*. Gives results of experiments at Trollhättan, Sweden. 1500 w. *Elec Rev, Lond*—July 12, 1912. No. 34658 A.

See also Canada, under ELECTRICAL ENGINEERING, *Electro-Chemistry*.

Fume Precipitation

Electrical Fume-Precipitation. F. G. Cottrell. On the commercial development of electrical methods of precipitating the suspended matter from smelter-smoke. General discussion. Ills. 4000 w. *Bul Am Inst of Min Engrs*—July, 1912. No. 34845 F.

Ingots

An Arrangement for Casting Small Ingots. Illustrates and describes a method used in two European steel plants for their production in large quantities. 800 w. *Ir Age*—July 4, 1912. No. 34248 C.

A New Method of Tapping Steel Ingots (*Sur un nouveau procédé de coulée des lingots d'acier*). M. J. Corbiau. Description of new process originated by M. Defays-Lanser. Ills. 3000 w. *Rev de Métal*—July, 1912. No. 34571 H.

Lake Superior

New Developments in the Lake Iron Ore District. A summary of events on the Minnesota and Michigan ranges since the beginning of the year. Ills. 7000 w. *Ir Trd Rev*—July 18, 1912. No. 34637.

Magnetic Ores

The Bearing of the Theories of the Origin of Magnetic Iron Ores on Their

Possible Extent. Frank L. Nason. Analysis, arguments and conclusions. 5000 w. *Bul Am Inst of Min Engrs*—July, 1912. No. 34847 F.

Metallography

Observations on the Structure of Some Rough Forgings (*Observations sur la Structure de quelques pièces brutes de forge*). A. Portevin and V. Bernard. Relation between their mechanical properties and the structure of "Widmanstätten." Ills. 1500 w. *Rev de Métal*—July, 1912. No. 34572 H.

Missouri

The Iron Ore Resources of Missouri. John Jermain Porter. Map and illustrated review of the iron industry of the State, and the iron ore deposits. 8500 w. *Mfrs' Rec*—July 8, 1912. No. 34635.

New York

Limonite Deposits of Staten Island, New York. Charles R. Fettke. Describes their distribution and occurrence. 2500 w. *Sch of Mines Qr*—July, 1912. No. 34625 D.

Nova Scotia

Annapolis Iron Ore Deposits in Nova Scotia. Gives results of a survey of the Canadian government and analyses of the ore shipped. Map. 1500 w. *Ir Trd Rev*—July 4, 1912. No. 34246.

Ore Reserves

Iron-Ore Reserves. Edwin C. Eckel. Discusses phases of the iron-ore-reserve problem, in both its industrial and political relations. 5400 w. *Engineering Magazine*—Aug., 1912. No. 34751 B.

Rolling Mills

Rolling High-Speed Tool Steel Bars. Illustrated description of the electrically driven rolling mill at Latrobe, Pa. Gives curves of the power requirements for rolling various sections. 1800 w. *Ir Age*—July 11, 1912. No. 34355 C.

Tests on the Electrically Driven Rolling Mills at the Julien Foundry, Oberschlesien (*Versuche an dem elektrisch angetriebenen Blockwalzwerk auf der Julienhütte, Oberschlesien*). L. Schnackenburg. Description of plant, installations, and tests, with results. Ills. and plates. 7000 w. *Elek Kraft u Bahnen*—June 14, 1912. No. 34521 D.

Steel Works

The Becker Steel Works in Willich (*Die Werksanlagen des Stahlwerks Becker in Willichs*). Illustrated description of this plant. Serial. 1st part. 3600 w. *Stahl u Eisen*—June 6, 1912. No. 34502 D.

LEAD AND ZINC

Graphite

Acme Graphite Mines and Mills. H. M. Beattie. An account of methods used at Byers, Pa. Ills. 3500 w. *Eng & Min Jour*—July 20, 1912. No. 34672.

Graphite in Quebec. H. P. H. Brumell. Information concerning the deposits and the recent improvement in the industry

due to solutions of problems of concentrating and preparing the product for market. Ills. 1200 w. Can Min Jour—July 1, 1912. No. 34268.

Zinc Retorts

The Chemical and Physical Reactions in a Zinc Retort. F. L. Clerc. Gives an analysis of the chemical and physical changes occurring within a zinc retort, with the view of discovering means of improvement. 4000 w. Met & Chem Engng—July, 1912. No. 34171 C.

Zinc Smelting

The Electric Smelting of Zinc Ore. W. R. Ingalls. Discusses the possibilities of electric smelting, reviewing types of furnaces, practice, cost, etc. 4500 w. Trans Can Min Inst—Vol. V. Part I. No. 3378 N.

MINING

Accidents

Mining Casualties in Newfoundland. Frederick L. Hoffman. Information from recent report showing that the regulations are good, and ignorance is the chief cause of accidents. 2500 w. Eng & Min Jour—July 20, 1912. No. 34674.

Costs

A System of Keeping Underground Costs and Records. G. Hildick Smith. Describes a system of tabulated cost sheets and graphic records introduced at the Ferreira Gold Mine. Also general discussion. 4500 w. Jour Chem, Met, & Min Soc of S Africa—May, 1912. No. 34710 E.

Diamond Drilling

Cost of Diamond Drill Equipment. Heath Steele. The first costs of hand and of power drills are given. 1500 w. Eng & Min Jour—July 13, 1912. No. 34428.

Methods of Taking a Number of Cores from One Diamond Drill Hole and of Surveying the Boreholes. Describes methods used in South Africa, illustrating the instrument used. 4000 w. Engng & Con—July 3, 1912. No. 34240.

Diamond Drilling at Point Mamainse, Province of Ontario. Alfred C. Lane. A record of diamond drilling carried on near this point on the east shore of Lake Superior during 1907 and 1908. Has a bearing on the copper resources of Canada. Ills. & map. 59 pages. Can Dept of Mines—Bul. No. 6. No. 34798 N.

See also Diamonds, under *Rare Minerals*.

Electric Power

Electric Mining Applications. E. A. Lof. Explains the advantages of the electric system and the applications made. Ills. 6000 w. Sch of Mines Qr—July, 1912. No. 34619 D.

The Factor of Safety in Mine Electrical Installations. H. H. Clark. Urges that the requirements of safety, as well as efficiency, be considered in the installation and operation of electrical mining

equipment. 4500 w. U S Bureau of Mines—Tech paper 19. No. 34371 N.

See also same heading, under *Iron and Steel*.

Gas Wells

Closing a Gas Well in Hungary. Excerpts from an article by A. Strobl. An account of attempts to close the well, and the disturbances following the closing. Ills. 2000 w. Eng & Min Jour—July 27, 1912. No. 34812.

Haulage

Conveyance of Workmen Underground. W. H. Pickering. Sketches and description of arrangements at British mines, where places of working are often at a considerable distance from the shafts. 1200 w. Ir & Coal Trds Rev—July 19, 1912. No. 34907 A.

Hoisting

See Wiring, under ELECTRICAL ENGINEERING, *Distribution*.

Hoisting Engines

Hoisting Engines (La Machine d'Extraction à vapeur). F. Gyseling. General description of the Bollinckx engines. Ills. and plates. 5000 w. All Industrielle—July, 1912. No. 34587 D.

Hoisting Ropes

The Factor of Safety in Hoisting Ropes (Der Sicherheitsfaktor der Schachtförderseile). Fr. Herbst. Notes, experiments and calculations for the determination of safe stresses. Diagrams. 6300 w. Glückauf—June 8, 1912. No. 34504 D.

Law

Mining Law in Nigeria. C. S. Herzig. A critical review of the general provisions of the law. 3500 w. Min Mag—July, 1912. No. 34728 B.

Methods

Mining Practices Compared. V. F. Stanley Low. Gives the author's impressions of mining and milling methods noted at various mining centers. 2500 w. Min Mag—July, 1912. No. 34729 B.

Mine Air

Notes on the Analyses of Mine Air Conducted at the Lewis Merthyr Consolidated Collieries, Limited, Trehafod. J. W. Hutchinson. From a paper read before the S. Wales Inst. of Engrs. Deals with methods used and discusses results obtained. 3500 w. Col Guard—July 19, 1912. No. 34891 A.

New Apparatus for Sampling Air for Dust. E. J. Laschinger. Illustrated description of the apparatus designed by the author, and its use. 2500 w. Jour Chem, Met, & Min Soc of S Africa—May, 1912. No. 34709 E.

Mine Inspection

Co-operative Mining Investigations in Illinois. H. H. Stoek. An account of the work done by the state in connection with the U. S. Bureau of Mines. 1500 w. Trans Can Min Inst—Vol. XV. Part I. No. 34379 N.

Miners' Lamp

A New Electric Miners' Lamp. D. B. Rushmore. Briefly reviews kinds of lamps used, and describes a new lamp recently developed by the General Electric Co. Ills. 2500 w. *Bul Am Inst of Min Engrs*—July, 1912. No. 34850 F.

Quarrying

A Machine for Sawing Granite. Frank C. Perkins. Illustrated description of this granite saw and its operation in New England quarries. 1500 w. *Sci Am Sup*—July 27, 1912. No. 34781.

Sampling

Mechanical Sampling of Ores. O. Binder. Illustrates and describes devices for taking samples from large or small quantities of ore. 2000 w. *Mines & Min*—July, 1912. No. 34183 C.

Sampling and Valuation of Ores. A. Rzehulka. Abstract trans. from *Montanistische Rundts*. Describes and discusses methods. 2000 w. *Min Jour*—June 29, 1912. No. 34315 A.

Shaft Lining

Improved Ferro-Concrete Shaft Lining. C. Meuskens. Illustrates and describes the system introduced by W. Breil. 1000 w. *Ir & Coal Trds Rev*—July 5, 1912. No. 34479 A.

The Application of Reinforced Concrete in Shaft Linings in Place of Masonry (*Verwendung von Eisenbeton beim Schachtbau an Stelle von Mauerwerk*). Herr Elwitz. Mathematical determinations of sectional area, safe dimensions, etc. Ills. 2000 w. *Glückauf*—June 8, 1912. No. 34505 D.

Timbering

Timbering a Small Shaft. John T. Fuller. Describes a rapid and efficient method suited to small, or temporary, shafts. Ills. 1000 w. *Mines & Min*—July, 1912. No. 34186 C.

Insect Damage to Mine Props and Methods of Preventing the Injury. T. E. Snyder. Information concerning the principal types of insect injury, showing how large a percentage can be prevented. 1500 w. *U S Dept of Agri, Circ 156*—July 13, 1912. No. 34833 N.

Valuation

The Valuation of Base-Metal Mines. W. H. Goodchild. Urges the establishment of a cosmopolitan mineral statistical bureau, and discusses the principal factors to be considered in appraising value. 2000 w. *Min Mag*—July, 1912. No. 34727 B.

See also Sampling, under *Mining*.

Ventilation

Three-Phase Cascade Motors for Ventilator Driving at the Werne Mines (*Ventilatorantrieb mit Drehstrom-Kaskadenmotor auf der Zeche Werne*). Herr Zederbohm. Description of motor and results of its operation. Ills. 2800 w. *Glückauf*—June 15, 1912. No. 34507 D.

MINOR MINERALS**Barytes**

Barytes: Composition, Distribution and Production. Baxeres de Alzugaray. Information concerning the distribution and sources of barytes, its preparation, etc. 1200 w. *Min & Engng Wld*—July 6, 1912. No. 34292.

Clay

The Quebec China Clay Industry. James G. Ross. Information concerning the Kaolin deposits and their recent development. Ills. 1500 w. *Can Min Jour*—July 1, 1912. No. 34269.

See also same heading, under *CIVIL ENGINEERING, Materials of Construction*.

Fullers' Earth

An Early Discovery of Fuller's Earth in Arkansas. J. C. Branner. A statement showing that Fuller's earth was mined in Arkansas as early as 1891. 700 w. *Bul Am Inst of Min Engrs*—July, 1912. No. 34851 F.

Manganese

Manganese Mining in the Russian Caucasus. Frederic W. Cauldwell. Describes the deposits and reviews their development. 2000 w. *Min & Engng Wld*—July 13, 1912. No. 34448.

Mica

Mica, Its Occurrence, Exploitation and Uses. Hugh S. de Schmid. A monograph giving information concerning the chief Canadian mica deposits. Maps & Ills. 411 pages. *Can Dept of Mines*—No. 118. No. 34797 N.

Mica Mining in the Province of Quebec. Hugh S. de Schmid. Illustrates and describes the deposits and their development. 2500 w. *Can Min Jour*—July 1, 1912. No. 34267.

Natural Gas

Compressing Natural Gas. E. D. Leland. Reviews the history of natural gas in the United States, and the development and installation of compressing stations, discussing related problems and giving information. General discussion. Ills. 8000 w. *Pro Engrs' Soc of W Penn*—June, 1912. No. 34802 D.

Potash

The Search for Potash in Western United States. Gordon Surr. Discusses points bearing on the possibilities of the desert dry lakes. 1500 w. *Min & Engng Wld*—July 20, 1912. No. 34689.

Alunite: A New Source of Potash. Guy Elliott Mitchell. An illustrated account of newly discovered potash deposits in Utah. 1500 w. *Cassier's Mag*—July, 1912. No. 34909 B.

Tin

The Occurrence of Tin. J. E. Carne. A description of the formations in New South Wales. 2500 w. *Mines & Min*—July, 1912. No. 34187 C.

Alluvial Mining on Goss Moor, Cornwall. J. E. MacNamara and H. E. Fern.

Illustrated description of the plant and method of working, the quality of the tinstone, and other information concerning the region. 2000 w. *Min Mag*—July, 1912. No. 34726 B.

A New Method of Dressing Cornish Tin Ores. Marcus Ruthenburg. Illustrated description of the Ruthenburg magnetic separator, outlining the old method used. 1200 w. *Met & Chem Engng*—July, 1912. No. 34172 C.

ORE DRESSING AND CONCENTRATION

Drying

Abrasion and Dust-Losses in Ore-Drying. Carl F. Dietz and Duke V. Keedy. Discusses the effect of the operations upon the ore itself and the recovery of the losses resulting from drying operations. 6000 w. *Bul Am Inst of Min Engrs*—July, 1912. No. 34849 F.

Flotation

The Flotation of Minerals. Kenneth A. Mickle. An account of further research work. 6500 w. *Eng & Min Jour*—July 13, 1912. No. 34427.

Low-Grade Mills

West End Consolidated Mill, Tonopah. J. P. Hart and H. L. Williams. Describes a 20-stamp, all-sliming, non-concentrating mill for treating low-grade silver ore. Ills. 4000 w. *Eng & Min Jour*—July 27, 1912. No. 34813.

Placer Concentrators

Dry Concentration of Placer Gold. F. J. H. Merrill. Describes types of concentrators used in placer mining. Ills. 2500 w. *Min & Sci Pr*—July 13, 1912. No. 34604.

Roasting

Methods of Blast Roasting of Sulphide Ores. C. L. Bryden. Abstract of a paper read before the Engrs'. Soc. of N.-E. Penn. Reviews the different methods, their advantages and limitations. 2500 w. *Min & Engng Wld*—June 29, 1912. No. 34136.

Sand Filter

The Caldecott Sand Filter Table. Illustrated description of this appliance. 1000 w. *Eng & Min Jour*—July 6, 1912. No. 34272.

Sizing

The Sizing of Fine Dry Ore. Charles H. Brown. Illustrates and describes the operating difficulties in sizing machines and how they were overcome. 3000 w. *Eng & Min Jour*—June 29, 1912. No. 34129.

Slimes

The Parral Tank System of Slime Agitation. Bernard MacDonald. Illustrated description. 1500 w. *Met & Chem Engng*—July, 1912. No. 34177 C.

Tailings

Treating Tailing Dumps. Describes the Stanley Classifier and its work. 1500 w. *Aust Min Stand*—June 6, 1912. No. 34481 B.

Tube-Milling

Pebbles for Tube-Milling. A. W. Allen. Calls attention to recent experimental work in England and America with road-repairing material, where the essential characteristics should be hardness and toughness. Gives results of tests. 1200 w. *Min Mag*—July, 1912. No. 34730 B.

Washing

Ore-Washing Plant of the Wisconsin Steel Co. C. A. Tupper. Illustrated detailed description. 2000 w. *Min & Engng Wld*—July 13, 1912. No. 34444.

See also same heading, under *Coal and Coke*.

RARE MINERALS

California

Notes on Rare Minerals from California. Austin F. Rogers. Brief descriptions of 26 specimens. 2500 w. *Sch of Mines Qr*—July, 1912. No. 34624 D.

Ceylon

Ceylon: The Island of Jewels. Leopold Claremont. Illustrated account of the rich industry in gem-minerals. 2000 w. *Sci Am Sup*—July 13, 1912. No. 34364.

Diamonds

Brazilian Carbons. J. K. Smit. Information concerning the hardest mineral found, and how to judge the value of the different varieties used for diamond drilling. 1500 w. *Mines & Min*—July, 1912. No. 34182 C.

Platinum

Platinum and the Platinum Group. E. de Hautpick. First of a series of articles on the varieties of platinum and related information. 1500 w. *Min Jour*—July 13, 1912. Serial. 1st part. No. 34711 A.

Tungsten

Tungsten in the Black Hills and Methods of Determination. E. H. Quinney. Abstracted from the *Pakasa Qr*. Describes these methods. 1200 w. *Min & Engng Wld*—July 13, 1912. No. 34445.

Vanadium

A Rapid Method for the Determination of Vanadium in Steels, Ores, Etc., Based on Its Quantitative Inclusion by the Phosphomolybdate Precipitate. J. R. Cain and J. C. Hostetter. Research undertaken to determine whether or not vanadium could be completely precipitated with phosphoric acid. 20 pages. *Tech Papers of Bureau of Stand*, No. 8—Oct. 26, 1911. No. 34600 N.

MISCELLANY

British Columbia

Annual Report of Minister of Mines, B. C. E. Jacobs. Statistics for the year 1911 showing the value of the mineral production. 3000 w. *Min & Engng Wld*—July 20, 1912. Serial. 1st part. No. 34688.

California

Geology of Harrison Gulch, in Shasta County, California. H. E. Kramm. Map, with detailed description. 2000 w. *Bul*

Am Inst of Min Engrs—July, 1912. No. 34848 F.

Geology

Faults. Ernest K. Hall. Notes upon means of distinguishing reverse from normal faults, with other observations. 1500 w. Aust Min Stand—June 13, 1912. No. 34483 B.

Philippines

Mineral Resources of Aroroy District, Masbate. Excerpts from a paper by Henry C. Ferguson, reviewing geological and topographical field work during 1907-08-09. Ills. 5000 w. Far East Rev—

May, 1912. No. 34827 N.

Mineral Resources of the Philippine Islands. R. Arthur. Describes the principal deposits and discusses the importance of the mining industry. Map. 1700 w. Min & Engng Wld—July 20, 1912. No. 34690.

South Dakota

Contribution to the Study of the Pre-Cambrian Rocks of the Harney Peak District of South Dakota. Gordon S. Duncan. An account of geological phenomena noted. 4000 w. Bul Am Inst of Min Engrs—July, 1912. No. 34852 F.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Collisions

The Lesson of Three Collisions. Reviews the three collisions occurring in the United States within two weeks, at Wilpen, Pa., Western Springs, Ill., and Corning, N. Y., and discusses causes. 3000 w. Ry Age Gaz—July 26, 1912. No. 34822.

The Lessons of Two Recent Collisions Under the Block System. Discusses the collision on the D., L. & W. at Corning, N. Y., and on the C., B. & Q. at Western Springs station near Chicago. 2200 w. Eng News—July 25, 1912. No. 34795.

Signaling

Automatic Block Signaling for Single-Track Railways. James B. Latimer. Reviews briefly the conditions and requirements, and illustrates and describes an automatic block-signal system of the C., B. & Q. R. R. 2500 w. Eng News—July 11, 1912. No. 34405.

The Application of Electricity to Railway Cab Signalling. William H. Dammond. Diagrams and descriptions of several systems of cab signals. 1800 w. Elec Rev, Lond—June 28, 1912. No. 34308 A.

The "Railophone" Inductive System of Automatic Signalling. Illustrated description of this system of train protection. 1800 w. Elect'n, Lond—July 12, 1912. No. 34706 A.

The Signal System of the New York, Westchester & Boston Railway. Illustrated description of the automatic block signals installed on a high-speed electric railway using alternating current. 6000 w. Elec Ry Jour—July 20, 1912. No. 34691.

Speed

Places Where Speed Is Reduced on Railways. Dr. Hans A. Martens. An examination of reduced-speed places, and their influence on the safety of working. 3700 w. Bul Int Ry Cong—July, 1912. No. 34734 G.

Train Control

The A. B. C. System of Train Control. H. F. E. Freeland. Reprint from the *Roy. Engrs. Jour.* Detailed description of this system as used on the N. Pacific Ry. and on the Delhi Durbar Ry. 9500 w. Ry Gaz, Lond—June 21, 1912. No. 34212 A.

Train Services

The Summer Train Services. An account of the programmes of railways in Great Britain. 2000 w. Engr, Lond—July 12, 1912. No. 34720 A.

MOTIVE POWER AND EQUIPMENT

Air Brakes

Foundation Arrangement Empty and Load Brake. Discusses transportation and control of traffic on heavy grades, requisite braking power, etc. 2000 w. Ry & Loc Engng—July, 1912. No. 34195 C.

Piston Travel Chart. Gives a small chart showing variation in braking power due to unequal piston travel and calls attention to a shock producer over which the engineer has no control. 1000 w. Ry & Loc Engng—July, 1912. No. 34196 C.

Brakes

See same heading, under STREET AND ELECTRIC RAILWAYS.

Couplers

Automatic Couplers on Railway Cars (Sur l'Attelage Automatique des Wagons de Chemins de Fer). J. Netter. Illustrated description of American and European types. 4000 w. Tech Mod—July 1, 1912. No. 34581 D.

Electrification

The Relation of Central Station Generation to Railway Electrification. Samuel Insull. Diagrams, discussion and results, comparing unified power supply with the group system for railway purposes. 10000 w. Pro Am Inst of Elec Engrs—July, 1912. No. 34864 F.

Electrification of the Butte, Anaconda & Pacific Ry., 2400 Volts Direct Current. Describes work in progress in Montana, and the system and equipment. 1000 w.

Ry & Engng Rev—July 6, 1912. No. 34302.

Locomotive Boilers

Note on Water-Tube Boilers of the Torpedo-Boat Type and Their Application to Locomotives. J. Robert. Compares smoke-tube and water-tube boilers, and explains the working. Ills. 4600 w. Bul Int Ry Cong—July, 1912. No. 34733 G.

Locomotive Fireboxes

The Relation of the Brick Arch to Locomotive Operation. John P. Neff. Explains the theory of the arch and what takes place in the locomotive firebox with and without the arch. Also discussion. 7500 w. Pro Ry Club of Pittsburgh—May 24, 1912. No. 34782 C.

Advantages and Disadvantages of the Use of Arches and Arch Pipes in Locomotive Fire-Boxes. From a committee report before the Master Boiler Makers' Assn., May, 1912. 2500 w. Boiler Maker—July, 1912. No. 34398.

Locomotive Fuels

See Gasoline Motors, under MECHANICAL ENGINEERING, *Combustion Motors*.

Locomotives

The Economical Limitations to the Size of Locomotives and Weight of Trains. Editorial discussion of the advantages and disadvantages of large locomotives and heavy trains. 2500 w. Eng News—July 18, 1912. No. 34651.

A Review of Locomotive Practice of To-day. Editorial aiming to show the lines of recent development, and some of the conditions influencing the development. 4000 w. Eng News—July 11, 1912. No. 34407.

Locomotive Developments of 1911. Reviews important features of development followed by leading railways of the United States. 3500 w. Eng News—July 11, 1912. No. 34401.

Recent Development of the Locomotive. George R. Henderson. Notes causes that have led to the production of more powerful locomotives, and illustrates and describes recent types and adjuncts and details. 14500 w. Jour Fr Inst—July, 1912. No. 34627 D.

A High-Power Passenger Locomotive. Illustrates and describes the special features of an experimental passenger locomotive of high power and relatively light weight, designed by the American Locomotive Co. 4000 w. Eng News—July 18, 1912. No. 34643.

Goods Engine for the East Indian Railways. Illustrations with brief description. 300 w. Engr, Lond—July 19, 1912. No. 34904 A.

Simple High Speed Articulated Locomotive. Drawings and description of an engine for the Canadian Pacific, intended for operating up to 50 miles an hour. 1500 w. Ry Age Gaz—July 12, 1912. No. 34423.

Anthracite Burning Pacific Type Locomotives. Illustrated detailed description of engines introduced by the Lackawanna to haul 460-ton trains at speeds of 30 miles an hour on 1.6 per cent grades. 1700 w. Ry Age Gaz—July 19, 1912. No. 34664.

Pacific Type Locomotives for the Delaware, Lackawanna & Western R. R. Illustrated detailed description of these new engines, calling attention to special features. 2000 w. Ry & Engng Rev—July 27, 1912. No. 34879.

Pacific Type Locomotive for the St. Louis & San Francisco R. R. Elevation, cross sections and description. 600 w. Ry & Engng Rev—July 6, 1912. No. 34301.

Relief Trains

The Relief Train of the Baden Governmental Railway (Die Hülfszüge der Grossherzoglich Badischen Staatseisenbahn). Courtin. Description of this combined wrecker and hospital train. Ills. and plate. 5000 w. Zeitschr des Ver deutscher Ing—July 6, 1912. No. 34560 D.

Reversing Gear

The Use of the Pneumatic Reversing Gear. Richard Sanderson. Illustrated description of a power reverse gear and its application to locomotives. General discussion. 7000 w. S & S-W Ry Club—May, 1912. No. 34801 C.

Rolling Stock

Rolling Stock Development on the South African Railways. An explanation of the railway development, and the rolling stock development, illustrating and describing the engines used since 1887. 2500 w. Engr, Lond—July 5, 1912. Serial. 1st part. No. 34475 A.

Shops

Methods of a Georgia Railway Shop. Ethan Viall. Describes interesting shop devices and methods. Ills. 1500 w. Am Mach—July 25, 1912. No. 34738.

Smoke

The Problem of Smoke Abatement So Far as It Relates to Steam Railroads. William A. Hoffman. Discusses the problem of eliminating smoke, the value of smoke-abating devices, inspection, etc. General discussion. 5000 w. Pro St Louis Ry Club—June 14, 1912. No. 34369.

Testing Methods

The Material Testing Department of a Railroad. E. B. Tilt. Abstract of a paper before the Can. Ry. Club. Notes on the progress of metallurgy and of testing metals. 4000 w. Castings—July, 1912. No. 34685.

The Test Department of a Railway. E. B. Tilt. Abstract of a paper read before the Canadian Ry. Club. Considers the duties of a railway engineer of tests and the work of the railway testing laboratories. 3500 w. Mech Engr—June 28, 1912. No. 34321 A.

Train Heating

Heating Trains by Means of Air Pump Exhaust. Illustrates and describes a special valve, called the "Econotherm," which automatically diverts steam from the air pump exhaust, into the train heating system, without increasing the back pressure. The essential parts of the system are described. Ills. 2500 w. Ry & Engng Rev—July 13, 1912. No. 34450.

Train Lighting

See Lamps, under ELECTRICAL ENGINEERING, *Lighting*.

Wheels

Effect of Wheel Coning on Sharp Flanges. Gives diagrams showing there has been great diminution in the breakage of flanges since the adoption of the standard coming 1 in 20 for car wheels. 500 w. Ry Age Gaz—July 17, 1912. No. 34665.

Locomotive Wheels. Describes old and modern wheels, keyways, tyres, etc. Ills. 2000 w. Mech Wld—June 28, 1912. No. 34325 A.

Wheel and Journal Maintenance on New York Subway. Illustrated description of the construction and methods of maintenance of wheels and journals in severe service. 2500 w. Elec Ry Jour—July 27, 1912. No. 34878.

NEW PROJECTS**Alaska**

Railroad Building in Alaska. Day Allen Willey. Illustrated account of the construction of the Copper River Railroad, and the remarkable problem in bridge building. 1700 w. Sci Am Sup—July 13, 1912. No. 34365.

Australia

Australia's Trans-Continental Railway. H. K. Ellison. Reviews the history of this work which is about to be executed. 2000 w. Jour Roy U Serv Inst—June, 1912. No. 34191 N.

Italy

Project for a New Direct Line from Northern Italy to Rome Through the Falterona (Per una nuova direttissima fra il Nord d'Italia e Roma attraverso il Falterona). Dante Fiorentini. Description of proposed route and tunnel, with map and profile. 7200 w. Monit Tec—July 10, 1912. No. 34590 D.

Oregon

Heavy Work on Spokane-Portland Short Line. Illustrates and describes work on a new line along Palouse and Snake Rivers. 1200 w. Eng Rec—July 20, 1912. No. 34676.

Panama Railroad

Reconstruction of the Panama Railroad. Gives facts as to the cost of the work and the present and prospective traffic, taken from a recent report of the railroad. 1200 w. Ry Age Gaz—July 5, 1912. No. 34255.

Yukon

Rainy Hollow, B. C., and Southwestern Yukon. E. Jacobs. Information concerning this country and resources through which it is proposed to construct a railway. Ills. 4000 w. Can Min Jour—July 15, 1912. No. 34640.

PERMANENT WAY AND BUILDINGS**Construction**

Difficulties in Constructing the Little Rock Southern Ry. J. M. Stark. Abstract of a paper before the Engng. Assn. of the South. Detailed account of the work. 3000 w. Eng News—July 25, 1912. No. 34793.

Extension

Building a Coal Road Extension Through the Pennsylvania Mountains. Illustrated description of the Lehigh & New England Railroad's new line to Tamaqua involving some difficult grading and a large bridge over the Lehigh River. 3000 w. Eng Rec—July 6, 1912. No. 34275.

Labor

The Negro as a Track Laborer. The second of a series of discussions of the characteristics of the various types of maintenance workmen. 3000 w. Ry Age Gaz—July 19, 1912. No. 34671.

Logging Roads

Building Railroads to Develop Lumber Districts in Arkansas. A. M. Van Auken. Also editorial. Discusses the economies of location and construction of logging railroads and their relation to steam railroads. Ills. 2000 w. Ry & Engng Rev—July 20, 1912. No. 34697.

Rails

Rail-Wear and Corrosion in the Simplon Tunnel. Notes abstracted from an article by A. Dänzer-Ischer in the *Schweizerische Bauzeitung*, giving results of investigations of the cause of heavy wear. 1500 w. Eng News—July 11, 1912. No. 34406.

Steel Rail Fractures. H. Hyatt. Traces the evolution of the rail from its beginning and explains some of the rail problems, the causes to which rail failures have been attributed, etc. 5000 w. Ap Sci—June, 1912. Serial. 1st part. No. 34829 C.

The Broken Rail in a Great Northern Wreck. From the report of James E. Howard to the Interstate Commerce Commission. Failure due to laminated seams and a split head. Ills. 4500 w. Ir Age—July 11, 1912. No. 34356 C.

Stations

Northern Pacific Ry. Station, Tacoma. Illustrated description of a large and beautiful station on the Pacific coast. 1200 w. Eng News—July 18, 1912. No. 34646.

Terminals

Canadian Pacific Passenger Terminal at Vancouver. Plans and description of

improvements in progress. 1000 w. Ry Age Gaz—July 5, 1912. No. 34259.

Rail and Water Terminals at Texas City. Harvey A. Thomas. Illustrates and describes improvements near Galveston, including new piers, warehouses, and grain elevator equipped with modern facilities. 1500 w. Ry Age Gaz—July 12, 1912. No. 34422.

Track Spikes

Tests of Holding Power of Track Spikes and Indentation by Tie Plates in Various Kinds of Timber. From a report on a series of tests carried out in the physical laboratory of the Armour Inst. of Tech. 1200 w. Engng & Con—July 24, 1912. No. 34777.

Yard Improvements

Yard and Shop Improvements at Boone, Iowa. H. Rettinghouse. Illustrated description of a terminal and repair plant of medium size, representing C. & N. W. practice. 4000 w. Ry Age Gaz—July 26, 1912. No. 34824.

TRAFFIC

Freight Loss

Frisco Freight Loss and Damage Bureau. An account of the work of the new freight loss and damage department, put in operation Sept. 15, 1911. 5000 w. Ry Age Gaz—July 26, 1912. No. 34825.

Rates

The Crosby Bill on Rate Regulation. Suggests a method of valuation of properties of public service carriers and outlines a suggested scale for a rate of return for new and old capital. 4000 w. Elec Ry Jour—July 20, 1912. No. 34692.

Reasonable Regulation of Railway Rates. Morrell W. Gates. Abstract from

Yale Rev. Discusses the building up of commerce by rate-making on business principles. 5000 w. Ry Age Gaz—June 28, 1912. No. 34124.

The Interstate Commerce Commission's Decision in the Express Company Cases. (Condensed.) Radical changes in methods and rates. 2500 w. Ry Age Gaz—July 19, 1912. No. 34668.

The Express Rate Cases. Editorial on the opinion rendered by the Interstate Commerce Commission. 1500 w. Ry Age Gaz—July 26, 1912. No. 34823.

Statistics

Graphical Presentation of Small Railway Statistics (Graphische Darstellungen der Kleinbahnstatistik). P. Müller. Explains a system for presenting costs, revenues, etc., graphically. Diagrams. 1600 w. Elek Kraft u Bahnen—June 24, 1912. No. 34523 D.

MISCELLANY

Legislation

Conference Committee Methods in Handling Railway Legislation on Mechanical Matters. Charles Arthur Seley. An address delivered before the College of Engineering, Urbana, Ill. 3500 w. Bul Univ of Ill—April 29, 1912. No. 34373 N.

The Stanley Committee's Recommendations. Gives text of the amendments to the Sherman law and summary of further legislation proposed. 3500 w. Ry Age Gaz—July 26, 1912. No. 34826.

Management

Influence of Supply Department Management on Operating Expenses. George G. Yeomans. Shows that it can be made to play an important part. 1500 w. Ry Age Gaz—July 19, 1912. No. 34666.

STREET AND ELECTRIC RAILWAYS

STREET AND ELECTRIC RAILWAYS

Brakes

A New Compensated Testing Brake. David Robertson. Drawings and description of a brake designed by the author. 2000 w. Elect'n, Lond—July 5, 1912. No. 34459 A.

Carhouse

New Haven Carhouse of the Connecticut Company. Illustrated description of two-story carhouse for double truck cars with grade entrance for each floor. 2500 w. Elec Ry Jour—July 13, 1912. No. 34419.

The New Nicollet Avenue Carhouse of the Twin City Rapid Transit Company. Illustrated description of a modern fire-proof carhouse and storage yard. 2500 w. Elec Ry Jour—June 29, 1912. No. 34142.

Car Meters

Are We Securing the Best Results from

Car Meters? William Clough. Abstract of a paper read before the Swansea Cong. Describes a bonus scheme for rewarding motormen on the savings obtained by using car-meters. 1200 w. Elect'n, Lond—July 5, 1912. No. 34458 A.

Electric Traction

Notes on the Operation of the Washington, Baltimore & Annapolis Railroad as a 1200-Volt System. John R. Hewett. On the economies effected and the satisfactory behavior and endurance of the apparatus, according to the amount of the service rendered on the road. 1500 w. Gen Elec Rev—July, 1912. No. 34232 C.

The Present and Future of Electric Traction (L'État Actuel et les Tendances de la Traction Électrique). M. L. Barbillion. Discusses the evolution of the mechanism of electric cars, former and present modes of operation, and the tendencies of

future development. In two parts. Part I. Ills. 1800 w. Tech Mod (Supplement)—June 15, 1912. No. 34578 D.

Electrification

The Electrification of the Budapest Local Roads (Die Elektrifizierung der Linien der Budapester Lokalbahnen). J. F. von Tóváros. Reviews the work of electrification of this street system. Ills. & maps. Serial. 1st part. 5500 w. Elek Kraft u Bahnen—June 24, 1912. No. 34522 D.

See also Electrification, under RAILWAY ENGINEERING, *Motive Power and Equipment*.

Elevated

The Hamburg Elevated Railway (Die Hamburger Hochbahn). W. Stein. An outline of the overhead structures, bridge and underground constructions of the line, and the power plant. Ills. 7500 w. Zeit d Oest Ing u Arch Ver—June 14, 1912. No. 34546 D.

The Service Plant of the Hamburg Elevated Railway (Die Betriebseinrichtung der Hamburger Hochbahn). W. Mattersdorf. Description of rolling stock, power stations and lines of this system. Ills. 6600 w. Elek Kraft u Bahnen—June 4, 1912. No. 34519 D.

Locomotives

The New Oerlikon Single-Phase Locomotives. Dr. H. Behn-Eschenburg. Illustrates and describes the main features of the new 2500 h.p. locomotive. 1200 w. Elect'n, Lond—June 28, 1912. No. 34312 A.

Electric Locomotives, N. Y., N. H., & H. R. R. Information concerning the three types tested, with illustrated description of new locomotives. 1500 w. Ry & Loc Engng—Aug., 1912. No. 34964 C.

Pay-As-You-Enter

Pay-As-You-Enter Cars at Galeshead. Illustrated account of the first application of this system in Europe and its reception. 1500 w. Tram & Ry Wld—July 11, 1912. No. 34599 B.

Pay-As-You-Enter and Its Advantages to the Tramway Companies and the Travelling Public. H. M. Howard. Abstract of a paper read before the Swansea Cong. Advantages are discussed and the application under British conditions is considered. 2500 w. Elect'n, Lond—July 5, 1912. No. 34461 A.

Power Economy

Investigation of Conditions for the Lowest Power Consumption in Railway Operation (Untersuchung der Bedingungen für den geringsten Arbeitsverbrauch beim Bahnbetrieb). Julius Fekl. Mathematical determinations, considering all things which are users of power. Serial. 1st part. 4600 w. Elek u Masch—June 23, 1912. No. 34516 D.

Rail Corrugation

See Tracks, under STREET AND ELECTRIC RAILWAYS.

Shops

Main Shops of the Stuttgart Street Railways (Hauptwerkstätte der Stuttgarter Strassenbahnen in Stuttgart). P. Loercher. Description of yard, plant layout, and equipment. Ills. 2200 w. Elek Kraft u Bahnen—June 24, 1912. No. 34524 D.

Power in Electric Street Railway Shops (Werkstattsbetrieb für elektrische Strassenbahnen). H. Schörling. Reviews the repair-shop equipment of the Hannover street railway system. Ills. 2700 w. Elek Kraft u Bahnen—June 24, 1912. No. 34525 D.

Single Phase

The Different Methods of Connecting Three-Phase Armature Windings for Single-Phase Service. W. J. Foster. Brief explanation with diagrams. 1200 w. Gen Elec Rev—July, 1912. No. 34231 C.

Single-Phase Railway Motors. Gives a description of a Bergmann single-phase motor and its application to railway working. Ills. 1500 w. Elect'n, Lond—July 19, 1912. No. 34884 A.

Subways

See Tunnels, under CIVIL ENGINEERING, *Construction*.

Switzerland

The Fribourg-Posieux Electric Trolley Bus Line (La ligne d'omnibus électriques à trolley Fribourg-Posieux). H. Maurer. Illustrated description of this line in Switzerland, installed in 1911. 1800 w. Bull Tech d l Suisse Romande—June 25, 1912. No. 34577 D.

Tracks

Track Maintenance. William Thorn. Read before the Swansea Cong. Advocates the systematic treatment of corrugations, and the elimination of defective joints. 2000 w. Elect'n, Lond—July 5, 1912. No. 34460 A.

Traffic

The Relation of Increase of Street Railway Traffic to Increase of Population. Extracts from a study made by George P. Watkins, one of the statisticians of the Public Service Commission of the First District of the State of New York. 8500 w. Engng & Con—July 10, 1912. No. 34412.

The Respective Values of Tramways, Motor Buses and Rail-less Traction as Means of Transport. A. H. Pott. Abstract of a paper read before the Swansea Cong. Discusses the present position of these means of transport. 3500 w. Elect'n, Lond—July 5, 1912. No. 34457 A.

1200-Volt

Notes on the Operation of the Washington, Baltimore & Annapolis Electric R. R. as a 1200-Volt System. An account of the working of this interurban line, re-equipped for operation by direct current. 1500 w. Ry & Engng Rev—July 13, 1912. No. 34449.

EXPLANATORY NOTE - THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; H, of \$1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc.. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

Alliance Industrielle. <i>m</i> . Brussels.	Bulletin of Dept. of Labor. <i>b-m</i> . Washington.
American Architects. <i>w</i> . New York.	Bull. of Can. Min. Inst. <i>qr</i> . Montreal.
American Jl. of Science. <i>m</i> . New Haven, U. S. A.	Bull. Soc. Int. d'Electriciens. <i>m</i> . Paris.
American Machinist. <i>w</i> . New York.	Bulletin of the Univ. of Wis., Madison, U. S. A.
Annales des Ponts et Chaussées. <i>m</i> . Paris.	Bull. Int. Railway Congress. <i>m</i> . Brussels.
Ann. d Soc. Ing. d Arch Ital. <i>s-m</i> . Rome.	Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. <i>m</i> .
Architect. <i>w</i> . London.	Liège.
Architectural Record. <i>m</i> . New York.	Bull. Tech. de la Suisse Romande. <i>s-m</i> . Lausanne.
Architectural Review. <i>s-q</i> . Boston.	Bull. Univ. of Illinois, Urbana, Ill.
Architect's and Builder's Magazine. <i>m</i> . New York.	Bureau of Mines, Washington.
Australian Mining Standard. <i>w</i> . Melbourne.	Canadian Electrical News. <i>m</i> . Toronto.
Autocar. <i>w</i> . Coventry, England.	Canadian Engineer. <i>w</i> . Toronto and Montreal.
Automobile. <i>w</i> . New York.	Canadian Mining Journal. <i>b-w</i> . Toronto.
Automotor Journal. <i>w</i> . London.	Cassier's Magazine. <i>m</i> . New York and London.
Beton und Eisen. <i>qr</i> . Vienna.	Castings. <i>m</i> . Cleveland, O.
Boiler Maker. <i>m</i> . New York.	Cement. <i>m</i> . New York.
Brass World. <i>m</i> . Bridgeport, Conn.	Chemical Engineer. <i>m</i> . Chicago.
Brickbuilder. <i>m</i> . Boston.	Chem. Met. Soc. of S. Africa. <i>m</i> . Johannesburg.
Builder. <i>w</i> . London.	Colliery Guardian. <i>w</i> . London.
Bull. Bur. of Standards. <i>qr</i> . Washington.	Commercial Vehicle. <i>m</i> . New York.
Bulletin de la Société d'Encouragement. <i>m</i> . Paris.	Compressed Air. <i>m</i> . New York.

- Concrete-Cement Age. *m.* New York.
 Cornell Civil Engineer. *m.* Ithaca.
 Die Turbine. *s-m.* Berlin.
 Domestic Engineering. *w.* Chicago.
 Economic Geology. *m.* New Haven, Conn.
 Electrical Engineering. *w.* London.
 Elec. Review and W. Elec'n. *w.* Chicago.
 Electrical Review. *w.* London.
 Electric Journal. *m.* Pittsburg, Pa.
 Electric Railway Journal. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnik u Maschinenbau. *w.* Vienna.
 Elektrotechnische Rundschau. *w.* Potsdam.
 Engineer. *w.* London.
 Engineering. *w.* London.
 Engineering and Contracting. *w.* Chicago.
 Engineering Magazine. *m.* New York and London.
 Engineering and Mining Journal. *w.* New York.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
 Far Eastern Review. *m.* Manila.
 Foundry. *m.* Cleveland, U. S. A.
 Génie Civil. *w.* Paris.
 Giesserei-Zeitung. *s-m.* Berlin.
 Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Glückauf. *w.* Essen-Ruhr.
 Heating and Ventilating Mag. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Refrigeration. *m.* New York.
 Il Cemento. *s-m.* Turin.
 Industria. *w.* Milan.
 Industrial Engineering. *m.* New York.
 Industrial World. *w.* Pittsburg.
 Ingegneria Ferroviaria. *s-m.* Rome.
 Ingenieur. *w.* Hague.
 Insurance Engineering. *m.* New York.
 Int. Marine Engineering. *m.* New York.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron Trade Review. *w.* Cleveland, U. S. A.
 Jour. of Accountancy. *m.* N. Y.
 Journal Am. Soc. of Engineering-Contractors. *m.* New York.
 Journal Asso. Eng. Societies. *m.* Philadelphia.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal N. E. Water Works Assn. *qr.* Boston.
 Journal Royal Inst. of Brit. Arch. *s-q.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of South African Assn. of Engineers. *m.* Johannesburg, S. A.
 Journal of the Society of Arts. *w.* London.
 Journal Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
 Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
 Journal Western Soc. of England. *b-m.* Chicago.
 Jour. of Worcester Poly. Inst., Worcester, U. S. A.
 La Nature. *w.* Paris.
 Le Yacht. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore.
 Marine Review. *m.* Cleveland, U. S. A.
 Mechanical Engineer. *w.* London.
 Mechanical World. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metallurgical and Chem. Engng. *m.* New York.
 Métallurgie. *w.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco.
 Mining Journal. *w.* London.
 Mining Magazine. *m.* London.
 Mining and Engineering World. *w.* Chicago.
 Mittheilungen des Vereins für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Moniteur Industrielle. *w.* Paris.
 Monitore Tecnico. *tr-m.* Milan.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 Municipal Journal. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
 Power and The Engineer. *w.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Ins. Electrical Eng. *m.* New York.
 Pro. Am. Ins. of Mining Eng. *m.* New York.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Pro. Am. Soc. Mech. Engineers. *m.* New York.
 Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
 Proceedings Engineers' Club. *qr.* Philadelphia.
 Pro. Engineers Society of Western Pennsylvania. *m.* Pittsburg.
 Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
 Progressive Age. *s-m.* New York.
 Quarry. *m.* London.
 Queensland Government Mining Jour. *m.* Brisbane, Australia.
 Railway Age Gazette. *w.* New York.
 Railway and Engineering Review. *w.* Chicago.
 Railway and Locomotive Engng. *m.* New York.
 Railway Gazette. *w.* London.
 Railway Master Mechanic. *m.* Chicago.
 Revue d'Electricité. *m.* Brussels.
 Revue d'Electrochimie et d'Electrometallurgie. *m.* Paris.
 Revue de Mécanique. *m.* Paris.
 Revue de Métallurgie. *m.* Paris.
 Revue Génie des Chemins de Fer. *m.* Paris.
 Revue Génie des Sciences. *w.* Paris.
 Revue Industrielle. *w.* Paris.
 Rivista Marittima. *m.* Rome.
 Rudder. *m.* New York.
 Schiffbau. *s-m.* Berlin.
 School of Mines Quarterly. *q.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific American Supplement. *w.* New York.
 Sibley Journal of Mech. Eng. *m.* Ithaca, N. Y.
 Société Belge des Electriciens. *m.* Brussels.
 Southern Electrician. *m.* Atlanta, Ga.
 Stahl und Eisen. *w.* Düsseldorf.
 Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
 Surveyor. *w.* London.
 Technique Moderne. *m.* Paris.
 Tramway & Railway World. *m.* London.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
 Wood Craft. *m.* Cleveland, U. S. A.
 Yale Scientific Monthly. *m.* New Haven.
 Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
 Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Chemistry

Analysis of Metallurgical and Engineering Materials. By Henry Wysor. Size, 10½ by 8¼ in.; pp., 82. Illus. Easton, Pa.: The Chemical Publishing Co. London: Williams & Norgate.

A manual intended for students in quantitative analysis, supplying practical methods for the analysis of such metallurgical and building materials as are brought to the attention of chemists.

Education

Report of the Commissioner of Education. Vol. II. By P. P. Claxton. Size, 9 by 5½ in.; pp., 1407. Washington: Government Printing Office.

Volume II of the report for the year ending June 30, 1911, contains the statistics of all universities, colleges, public and private high schools, commercial and business schools, institutions and reformatories, and also of all common and city schools wherever statistics were available.

Fire Prevention

Fire Prevention and Fire Protection. By Joseph Kendall Freitag. Size 7¼ by 4¼ in.; pp., 1038. Illus. Price, \$4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A handbook of theory and practice as applied to building construction. Contains chapters on fire tests and materials; fire-resisting design and construction; special structures and safeguards.

Highways

Roads, Paths and Bridges. By Logan Waller Page. Size, 7½ by 5 in.; pp., 263. Illus. Price, \$0.75. New York: Sturgis & Walton Company.

An extremely clear exposition on the general subject of highway construction, carefully written and edited for the benefit of the layman who may wish applied information. The best practice at home and abroad is outlined, and fitting comparisons of good and bad construction carefully explained.

Iron and Steel

Statistics of the American and Foreign Iron Trades, Part I. Edited by James M. Swank. Size 9 by 5¾ in.; pp., 104. Price, including Part II, \$5.00. Philadelphia: The American Iron and Steel Association.

Part I, of the Annual Report for 1911 of the American Iron and Steel Association,

contains detailed statistics of the iron and steel industries of the United States, also statistics of the coal, coke and shipbuilding industries, immigration, etc. Part II will appear at a later date.

Labor

Annual Report of the Department of Labor, of the State of New York. Size, 8¾ by 5¾ in.; pp., 1149. Albany: State Department of Labor.

For the twelve months ended September 30, 1910. Volume I includes the reports on factory inspection, mercantile inspection, and the bureau of mediation and arbitration.

Railroads

Railroad Operating Costs. Vol. II. By Suffern & Son. Size, 11 by 8 in.; pp., 144. Illus. Price, \$2.00. New York: Suffern & Son.

This volume contains some of the material of the preceding volume strengthened and amplified by new material. In the chapter of maintenance of way and structures, the "locomotive tractive mile" has been introduced as a unit of cost determination. Particular attention is paid to the subject of full costs in relation to locomotive performance.

Reinforced Concrete

Reinforced Concrete Construction. By George A. Hool. Size, 9 by 6 in.; pp., 250. Illus. Price, \$2.50. New York and London: McGraw-Hill Book Company.

This work is to appear in three volumes. Volume I covers the fundamental principles, including numerous tables and diagrams to facilitate the calculation and design of structures. Volume II is to be on the design of retaining walls and buildings, and Volume III on the design of bridges.

Works Management

The Human Factor in Works Management. By James Hartness. Size, 7¾ by 5¼ in.; pp., 159. Price, \$1.50. New York and London: McGraw-Hill Book Company.

An attempt to set forth some of the essential principles of industrial economics. Emphasis is laid on the modes of employment of mind and body most favorable to the comfort and success both of the man and of the organization. Attention is also paid to the value of habit as a means toward obtaining progress.

IMPROVED MACHINERY

NEW METHODS

NEW PROCESSES

NEW MATERIALS

NEW APPLIANCES



The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

OILING SYSTEMS THAT PAY 100% DIVIDENDS

MR. WILLIAM L. MORRIS, M. E., expert on lubrication with S. F. Bowser & Co., Inc., Fort Wayne, Ind., has furnished the following argument and figures of results attained by the stream feed lubrication system, which he terms a "100 per cent system":

"The economy that can be derived from the re-use of oil is so variable that there must of necessity be opponents as well as advocates to its use. The great disparity in results obtained is not so much the variation in the journals to be lubricated as it is the methods employed to clarify and supply oil to the journals. Nearly all the manufacturers of oiling systems of to-day are using the same devices and arrangements that they employed while this system work was in its infancy, using the old hand supplied filters with a few minor modifications to serve as a part of an oiling system.

"An oiling system that will reduce friction 5 per cent will effect savings in one year's time sufficient to pay the entire cost of installation, and if run 24 hours a day it will effect even more. To secure the ultimate savings possible it is necessary that the

system be exceedingly large in all its provisions, and that it can be easily kept clean. It should be possible to clean all parts of the system while it is in service: men don't work overtime if they can get out of it, the result being that cleaning would be neglected. A 100 per cent system can not be obtained with less than 2 square feet of filtering surface for each gallon of oil filtered per hour and the capacity should be not less than 200 times what would be possible with a minimum hand feed. The per cent value of a system closely approximates the amount of surface furnished and, in common with all machinery, the price does not increase as much as indicated by the quantity. If an engine room be supplied with a small system having 10 sq. ft. of surface when it should have 100 there will be a constant yearly loss of nine-tenths the value of the larger 100 per cent system. A sample list of savings are here tabulated, using a sample plant as an illustration:

Three 500-kilowatt engines, run 20 hours per day; average, full load, 12 hours, 300 days per year. Coal consumption, 10 pounds per kilowatt hour. Coal cost, per

ton, \$1.80. Unloading, firing, cleaning ashes, cleaning boilers, etc., \$.40 per ton.

Coal cost per year:	
27,000 tons at \$1.80...	\$49,600.00
Coal handling at \$.40 per ton.....	10,800.00
	<u>\$60,400.00</u>

5% frictional savings.	\$3,020.00
24 barrels at 50 gal. at \$0.40	\$480.00
6 barrels with system at 50 gal. at \$0.15...	45.00
	<u>Oil saving.....</u>
	435.00
Repairs to journals...	\$100.00
Repairs with system, 20%	20.00
	<u>Saving in repairs.</u>
	80.00
Shut downs, loss of labor, materials and profit	75.00
Value of engines, etc., that would be lost when worn out, \$100,000.00. Life by hand feed, 25	

years = \$4,000.00 per year depreciation; life by stream feed, 40 years, or, per year, \$2,500.00.	
Yearly saving in depreciation.....	1,500.00
20% of the time of oilers utilized for useful work, \$1,200.00 × 20% = ...	240.00
Savings, occasioned by removing vibration to foundations, piping, etc., disregarded.....	000.00
	<u>Total savings.....</u>
	\$5,350.00

Cost of system to effect these economies, including necessary oil guards, cups, piping and installation 2,675.00

“The figures as given show a 200 per cent system, this being possible if plant runs as many hours as noted and other conditions being as shown. It is only in plants using refuse for fuel or other exceptional conditions that would not permit a 100 per cent saving if provided with a 100 per cent system.”

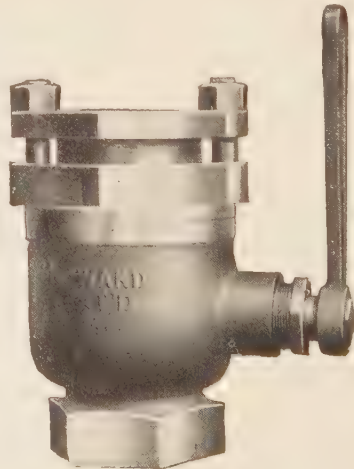
THE HOWARD BALL VALVE

IN the accompanying illustration the Howard ball valve is shown in detail. It is particularly designed for blow-off usages, but it is adapted for all purposes where ordinary cocks are used.

Bronze metal, the characteristic structure of this valve, is a mechanical mixture of few substances and varying elements of near affinity, and the component parts are, through metallurgical chemistry and the scientific processes of blending, so proportioned as to control the product, while only partial, intermittent, and variable control can be exercised over the processes in the manufacture of articles of iron, or complex compounds with iron for its chief constituent.

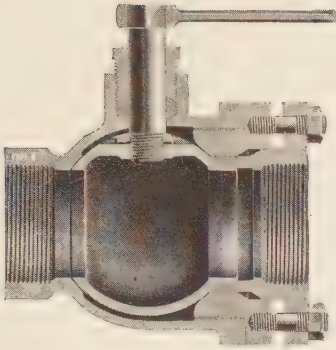
Referring to the sectional view of the valve it is seen that the distribution of the metal insures rigidity and

ample resistance to all possible strain, and has ample thickness of metal to provide for working pres-



ures of 300 pounds, for which it is designed.

The valve is further tested to a pressure considerably higher than



its working pressure to safeguard against water-hammer, violent shocks or unusual strain or stress of any kind. Being manufactured entirely of a guaranteed steam bronze, there is no unequal expansion or contraction or rusting effects from boiler or other injurious compounds.

Having no mechanical or complicated adjustments, there is nothing to get out of order and it does not require an expert to care for it. There are no sticking plugs, jamming wedges, tempered springs, unscrewing discs, regrinding seats, rebabbit-

ting parts or faulty construction. It has full area of the pipe line, straight through blow, opens and closes with a quarter turn. Sediment cannot affect the ball. It has self-wiping and cleaning seat. All parts are interchangeable. It is adjustable to take up packings, and can be easily, quickly and cheaply repacked. The efficiency of a valve depends upon the wearing surfaces that can be produced and maintained under service. This valve, in its mechanical construction, has no metal-to-metal friction. The stem and ball have bearings against the packings only; yet steadying them centrally, firmly and positively. The greater the pressure, the tighter the valve. The ingredients of the packings are all of softer materials than the ball or stem, and it is impossible for the packing to cut, score or injure these parts.

The Howard ball valve is made by the Howard Iron Works, Buffalo, N. Y., who will send a fuller description on request.

THE REMEDY FOR DAMP WALLS

A MEANS of preventing the penetration of dampness and water through structures such as foundations, cellar-walls and floors, tunnels, dams, reservoirs, swimming pools, and other concrete work, has often proved a difficult problem. Concrete is porous because of the voids between its contents. Under a glass a fresh surface of fracture shows that the pieces of stone and sand are smeared over with a very thin coating of cement wash with considerable remaining voids. Through these voids water will pass by gravitation and capillary attraction. To make the concrete waterproof, two principal methods have

been tried. One is the filling of the mass throughout with a non-porous substance, or the treating of the surface so as to make it watertight. The objection to the surface coating is that it is easily broken or rubbed off in spots and is too weak to be serviceable as a waterproof coating should be. It is not satisfactory to waterproof the mass of concrete in such a way as to leave this important property at the mercy of continued watchfulness and renewals. A satisfactory waterproofing must be as durable as the concrete itself.

A waterproofing compound which is mixed with and becomes an integral part of the structure is known as

Ceresit, a cream-white paste of about the consistency of butter. Ceresit paste is simply added to the water used in mixing the mortar or concrete and penetrates with the water to all parts of the concrete or mortar, assuring a permanent waterproof and dampproof structure. Among the properties of Ceresit may be mentioned that in addition to preventing penetration of any moisture whatever, it does not affect the original strength of the cement, and is so inexpensive as to make it a means of

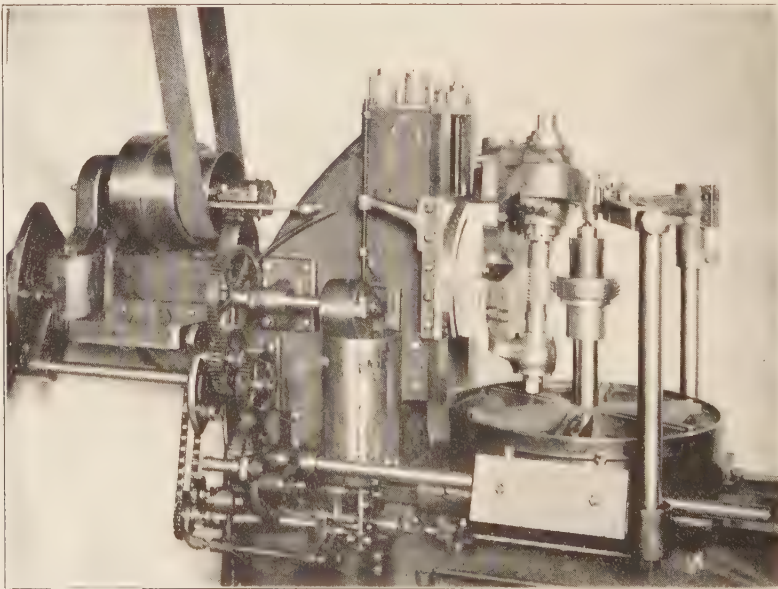
real economy. The many structures in which it has been used are continual evidence that it prevents the penetration of water, even under heavy pressure, as in dam, reservoir, bridge and similar work.

The Ceresit Waterproofing Co., 446 Commercial National Bank Building, Chicago, have published a pamphlet, sent free on request, illustrating many structures whose walls have been waterproofed in the manner described, and giving a list of local agencies.

FARWELL UNIVERSAL SPIRAL GEAR HOBBER

THE Adams Company, Dubuque, Iowa, has added to their line of gear hobbing machines a No. 4, adapted to cut

ceedingly wide range of feeds and table speeds as to make it universal. It can be arranged, and change gears can be furnished, to cut a single



spur, spiral, worm wheels and worms, up to 24 inch diameter, 3 pitch in cast iron, $3\frac{1}{2}$ pitch in steel. This machine is capable of such an ex-

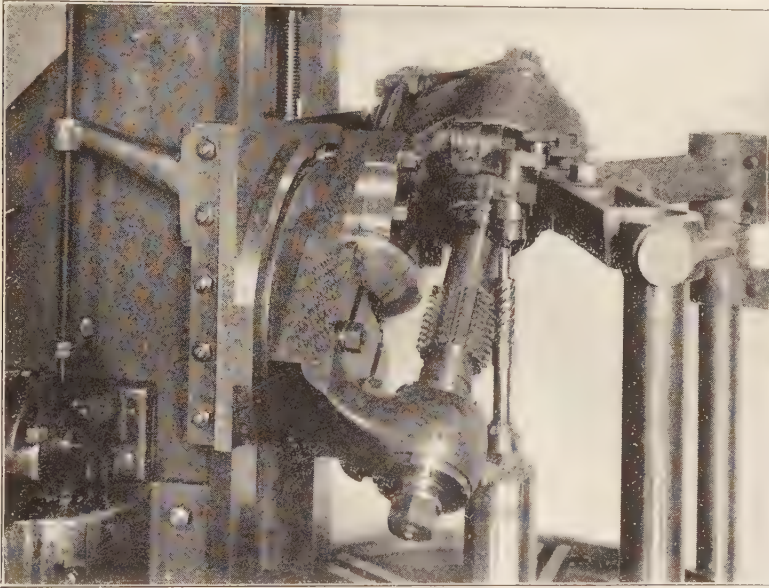
thread worm or a screw of fine pitch, and from that on up through all pitches and numbers of teeth of worm, spiral and spur gears, includ-

ing all prime numbers up to a thousand or more.

The vertical feeds of the cutter head range from .002 to .500 inch to one revolution of the table. The table may be geared to make one revolution to two revolutions of the cutter, or it may be geared to make one revolution to a thousand or more revolu-

tral enclosed bevel gear drive to enable the head to be swiveled to any angle. It is impossible with this drive to secure the compactness and rigidity to the cutter head that characterizes the Farwell No. 3 gear hobber having the outside drive.

Unusual weight and width of saddle and swivel is provided in the



tions of the cutter. This exceedingly wide range of feeds and table speeds is, of course, unnecessary for ordinary spur, spiral and worm gear cutting and no additional complication was resorted to, to obtain this wide range. The design of the drive of the table and feeds is such that the compounding of a comparatively small number of moderate size gears enables this range to be had.

The machine is especially designed for gear and worm hobbing, but the slow table travel obtainable, relative to the cutter speed, enables the machine to be used also as a continuous or circular milling machine. A special spindle and bracket may be had for this purpose.

A hobbing machine to cut spiral gears and worms necessitates a cen-

tral enclosed bevel gear drive to enable the head to be swiveled to any angle. It is impossible with this drive to secure the compactness and rigidity to the cutter head that characterizes the Farwell No. 3 gear hobber having the outside drive.

Unusual weight and width of saddle and swivel is provided in the Farwell No. 4 to increase the rigidity to the greatest extent. The cutter spindle is large and has a hole clear through, through which the arbor proper passes, and is driven by a long key and feather. Adjusting nuts on the arbor at each end of the spindle provides for an end adjustment of the hob to facilitate setting one tooth central and to shift to fresh cutting position.

The spindle is driven by a steel spur gear and pinion, and both spindle and pinion shaft run in adjustable bronze bearings on each side of the gears, thus equalizing the strain.

There is but one pair of bevel gears in the spindle drive train, two pairs less than usually used in swivel head construction. There is no long

spliced shaft and sliding key used in the drive.

A reducing gear of large diameter is interposed between the cone pulley shaft and a universal joint shaft which communicates power to the spindle. This is the same drive which has been found so satisfactory in the No. 3 machine.

The universal joints are of special design, are very strong, provided with large wearing surfaces of steel on bronze, have ready means to compensate for wear, and have felt oil retaining pads to facilitate lubrication.

The cutter head has a vertical power feed ranging from two thousandths to one-half inch to each revolution of the table. An automatic stop and a rapid power return is provided.

The table saddle has a power inward feed ranging from one-quarter thousandth to three-eighths inch to each revolution of table. An automatic depth stop is provided for worm wheel hobbing.

The table may be geared to cut anything from a single threaded worm to a gear having a thousand or more teeth, including all prime numbers. A regular set of change gears, 120 in number, will give all feeds above and will cut all gears to

200 and many composite numbers above. Special gears can be furnished to cut all other numbers, including all prime numbers.

The countershaft furnished is provided with three clutch pulleys. The lubricating pump is arranged to be run in the right direction when the direction of spindle is reversed. The table is driven by a steel worm engaging a bronze ring worm wheel. This worm wheel is 20 inches in diameter in this 24-inch machine.

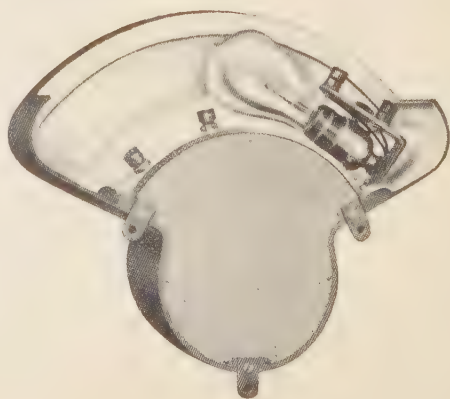
Provision is made for easily taking up any wear either in the mesh or end motion of the worm. The table is of heavy rib or spoke and rim construction, but the top between the ribs, instead of being level, is depressed in a cone shape with a hole in the center.

This conducts all cuttings and lubricant into a pan in the base of the machine. The lubricant drains out of the pan into a tank below. The pan may be easily removed through the door and contents dumped, handles being provided for this purpose. The weight of the machine complete is about 3,900 pounds. It is adapted to cut spur, spiral or worm gears up to 3 pitch, 24 inches diameter.

Fuller details may be had from the builders, the Adams Company, Dubuque, Iowa.

NEW ILLUMINATED DIAL INDICATOR

THE Brown Instrument Company of Philadelphia are adding to their line of electrical pyrometers, a new illuminated dial indicator, with exceptionally long scale. Frequently an instrument is desired which can be easily read by the operator of the furnace or kiln at some distance, and the new Brown pyrometer with illuminated dial is particularly desirable for such conditions. This new instrument with extra long scale of 12 inches can be



furnished with or without illuminated dial, as desired. Where the illumination is sufficient, the instrument does not require an illuminated dial, but the long scale affords very open gradations, and accurate readings. In many plants, however, such as dark shops for hardening and heat treating steel, and where work is carried on day and night, the illuminated dial instrument is preferable. The

scale is drawn on opaque glass, and a 16-candle power lamp placed behind the scale makes the graduations and the pointer stand out clearly at a distance.

The operator using the instrument appreciates the advantages of such an instrument, and uniformly better results are secured through the ability of the engineer to secure more accurate readings of the temperature.

INDUSTRIAL NEWS NOTES

—Messrs. Toch Brothers, 320 Fifth avenue, New York, have published a pamphlet entitled "Toch's Steel Paint Specifications," which contains a wealth of suggestion to all who are interested in the protection and preservation of structural steel work. It is sent free on request.

—While Medusa White Portland cement has been on the market for only a few years, foreign shipments are already being made, and an order for five cars has just been shipped to Sydney, Australia, and two cars to Delagoa Bay, South Africa. Several thousand barrels will also be used on Woolworth building, New York, the highest office building in the world.

—The fourteenth annual convention of the National Metal Trades Association will be called together at 9 o'clock on Thursday, April 11, at the Hotel Astor, New York City, where all the sessions, luncheons, and banquets of the convention are to be held. The Administrative Council of the Association meet on the day preceding the assembly of the convention itself, a feature of the council meeting being a luncheon from 12 to 2 o'clock, at which the labor bureaus will be discussed with the presidents and secretaries of local

branches of the association. The convention banquet will be held on the evening of the 11th, and it is announced that three of the best informed men on up-to-the-minute subjects will speak on this occasion. Special interest is expected to characterize all the sessions. In view of the many important matters belonging especially to the field of the association that are now before the country, and of the distinguished membership ready to take part in the discussion, this expectation is likely to be fully realized.

—The Salt Lake office of the Sullivan Machinery Co. has removed from the Dooly Building in which it has been located for the last five years, to the Kearns Building, Room 704, se-therby securing much-needed additional space for the conduct of the business in that city. Mr. M. G. Doll is local manager.

—Mr. C. W. Stone has been appointed manager of the Lighting Department of the General Electric Co. to succeed Mr. C. D. Haskins, deceased.

—The Triumph Electric Co., of Cincinnati, Ohio, have recently opened a district office at 2219 Farmers' Bank Building, Pittsburgh. Formerly they were represented by the Doubleday-Hill Electric Co. in that territory, but the rapidly increasing busi-

ness made it seem advisable to have direct representation in this important center. Mr. D. D. Gill will be in charge of the new office.

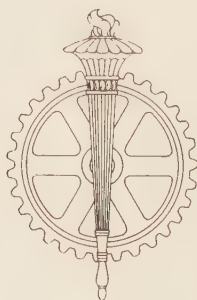
—The Kerr Turbine Co., Wells-ville, N. Y., advises that over 700 of their machines, aggregating more than 50,000 horse power, are in active service and that more unfilled orders are now booked than at any previous time in the history of the company. Although their plant has been materially enlarged, a night shift has been necessary for the past two and a half years. Among recent orders are the following: One 350 kw. turbo-alternator for the Brooklyn refinery of the Standard Oil Co.; two 2,800 gal. per min. turbo-pump units for Tidewater Oil Co.; two 75 kw. and one 35 kw. lighting sets to American Shipbuilding Co. for the new steamer *City of Detroit*; two 75 kw. lighting sets for waterworks service, city of Chicago; one 60 b. h. p. turbo-generator with prony brake attachment for the University of Melbourne, Australia; one 215 h. p. turbo-blower for Peoples Gas, Light and Coke Co., Chicago; two underwriter fire pumps driven by 200 h. p. Kerr turbines for Steger & Sons piano factory, Steger, Ill.; one fire pump driven by 265 h. p. Kerr turbine for B. M. Osburn Co., Chicago. This last named will be the

only turbine-driven fire pump in the city of Chicago.

—The Hydraulic Press Mfg. Company of Mount Gilead, Ohio, have recently completed arrangements for installing a new brass foundry for the purpose of making the many brass castings used on their hydraulic machinery. By this arrangement a corps of skilled workmen will be brought to Mount Gilead and the company will be put in a position to provide for all their needs in the brass casting line and attend to many outside calls as well. This company manufacture an extensive line of heavy hydraulic machinery and high power pumps. All equipment is modern in every particular. The entire plant, covering fourteen acres, is operated by electricity generated in the company's own power house.

—Mr. O. D. Hogue has been appointed Vice-President and Treasurer of The Goulds Manufacturing Company of Illinois.

—Mr. Frank L. Sessions has been appointed superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Sessions is a graduate of Worcester Polytechnic Institute, 1889, a member of the American Society of Mechanical Engineers and a member of the American Institute of Electrical Engineers.



IMPROVED MACHINERY

NEW METHODS
NEW PROCESSES

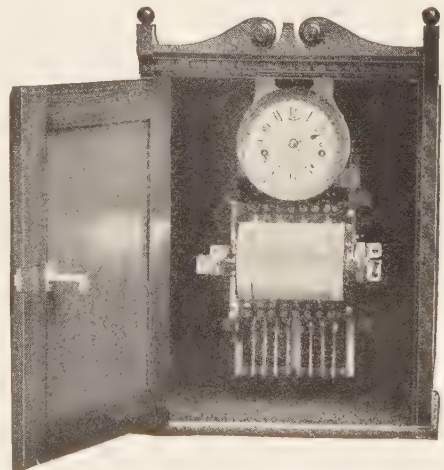
NEW MATERIALS
NEW APPLIANCES

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SIMPLEX WATCHMAN'S RECORDER

THE Simplex watchman's recorder is designed to keep an accurate record of the rounds or movements of any number of watchmen. The recorder is placed in the office or at some central point and contains a record sheet revolved by clockwork. In the Simplex the round dial hitherto universally used has been discarded and a rectangular straight ruled sheet has been substituted. This sheet is the feature which distinguishes the Simplex from every other type of watchman's recorder. The time is shown by straight, vertical lines, ruled in ten-minute divisions. The record from each station thus appears in a separate horizontal space between two straight lines. The resulting record is the easiest possible record to read, the sheet telling at a glance everything that is on record. It is not necessary to revolve the sheet and follow each trip separately around an arc of a circle, and the length of time divisions is not constantly changing in different parts of the sheet. A space which means ten minutes for one station means ten minutes at every other station, and not an hour, for instance, at another station on a smaller circle.

Another advantage is that the relative time consumed by the watchman on various parts of his route, is shown in exact proportion so that a single glance shows the exact movements of the watchman at all times. The advantage of this will be recog-



nized over the variable time division which distorts the relative time and destroys the most important means for detecting delays or irregularities in the watchman's rounds.

The central recorder contains a number of magnets corresponding to

the number of recording points or stations. These magnets are connected by wires to the watchman's stations throughout the plant. Each station consists of a small magneto generator of the type commonly used for telephone call boxes. The watchman carries a crank key fitting all stations, and by inserting this key in each station and giving the armature shaft a turn, the electric current is sent through the corresponding mag-

net in the recorder. The magnet attracts its lever, and causes a prick pin to perforate the record sheet, showing the hour and minute at which the station is visited. Each station actuates its own lever and has a separate space on the sheet for its record.

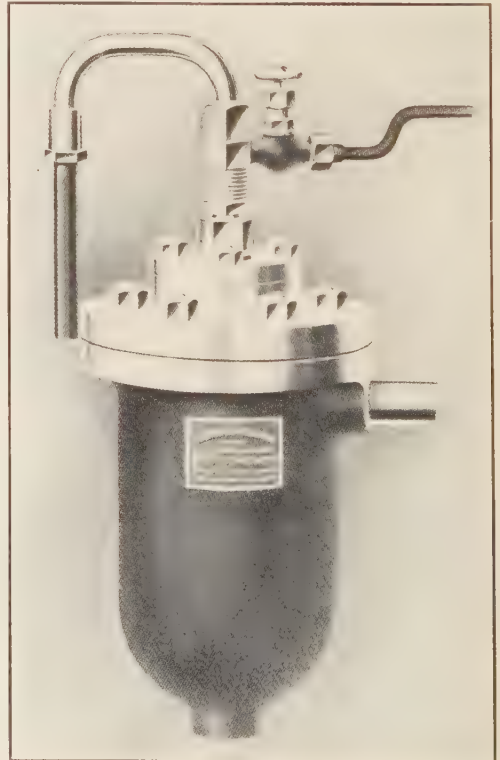
This device is made by the Simplex Time Recorder Co., Gardner, Mass., who will send a sample record sheet and descriptive pamphlet on request.

THE THERMOFEED WATER REGULATOR

IN every boiler there is a height at which, if the water level is kept constant, the fullest efficiency is obtained from the fuel consumed. The reasons for this are obvious to any engineer, because in every boiler there is a fixed grate surface or furnace area, capable of giving out a certain heat with any given fuel, the result of careful design of flues, draught-area, and other means, assuring the complete combustion of the fuel, to the end that the heat units are all set free, and capable of doing useful work; but if, as is the case to a greater or less extent in every boiler whether land or marine type, water tube, or Lancashire, the amount of water is varying from an excess to a deficient quantity, then a moment's thought will let it be seen that some of the heat units are merely used in increasing the temperature of the flue gases (if water deficient) or spent mainly in elevating the temperature of a body of water up to the steam-raising or evaporation point, instead of actually producing steam at the required pressure.

It is known that to convert every pound of water at 212° Fah. into steam at the same temperature and

at atmospheric pressure, requires an expenditure of 966.6 B. Th. U.'s, this being called the latent heat of steam; the "sensible" heat is the number of B. Th. U.'s necessary to raise the temperature of the water from its



initial temperature to that temperature which is the evaporated temperature at the boiler pressure. These two, viz.: the latent heat and the sensible heat, added together, are called the total heat of the steam, and this varies for different pressures.

It will therefore be seen that if a machine could prevent any departure from the fixed level, it would have a place in every modern plant. The Thermofeed does maintain the level to within $\frac{1}{8}$ in. The Thermofeed is reliable, because it has one simple mechanically operated valve and nothing more; so simple that it is extraordinary it has not been thought of before.

The Thermofeed operates independently of the pressure of the steam and of the temperature of the feed.

A uniform level is a prime object to be aimed at, and with the Thermofeed the variation does not exceed $\frac{1}{8}$ in. in any boiler fitted with it. This unvarying level means the heating of a uniform body of water at all times, no plunging of an unnecessary quantity of cold water into an already heated boiler (even if the water is

heated to 212° , it is cold compared to boiler temperature) to cause forced firing and undue expansion and contraction of the plates and consequent straining of rivets and seams.

The Thermofeed Regulator actually feels the water level changes before they would be visible in the gauge glass, so sensitive is it in its action.

It is evident and obvious that if the water level of a boiler is maintained at its most economical fixed height, a great saving in fuel results.

It is, therefore, economical to get a machine which will do the work automatically, and regulate the flow of feed water so that a constant level is maintained, irrespective of what H. P. the boiler is developing, or what quality or quantity of fuel is being used.

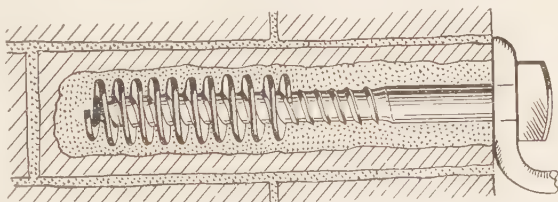
The Thermofeed water regulator is made by Ronald Trist & Co., Ltd., Coronation House, 4 Lloyd's Avenue, London, England, who will be pleased to send descriptive catalogues on application. They are also prepared to license or sell the Canadian and American patents for the manufacture of the Thermofeed regulator in America.

RICHMOND SCREW ANCHOR

THE great difficulty in fastening bolts or screws in concrete, stone or similar materials, because the shallow threads of the screw do not provide of themselves sufficient bearing surface to sustain a load, led to the production of the Richmond Screw Anchor, a patented device of astonishing simplicity. It consists simply of a specially designed helical coil fitting the thread of the screw and cast into place with it.

Grease or mill-scale remaining

from manufacturing operations provides an anti-bonding film upon the screw which permits the latter to be



easily withdrawn from the hardened concrete, while the metal anchor forms a screw bore that will not wear out, tear out, chip off or enlarge un-

der a load on the screw or under repeated removal and insertion.

When concrete work is in course of construction the anchor and screw may be placed in final position and the concrete allowed to harden around them. If this is not convenient the usual method of cementing the bolt and anchor in a drilled hole with neat cement is employed as in brick- and stone-work.

The low cost of the device makes its uses both extensive and varied; it covers the entire field of expansion bolt work and a great many instances where the expansion bolt cannot be conveniently used. Among the applications are:

Fastening and holding: Shaft hangers and sprinkler, water, steam and other pipes to walls and ceilings; engines and machinery to foundations; partitions and railings to concrete floors; hand rails and fencing to copings; screw spikes to railroad ties, etc., etc.

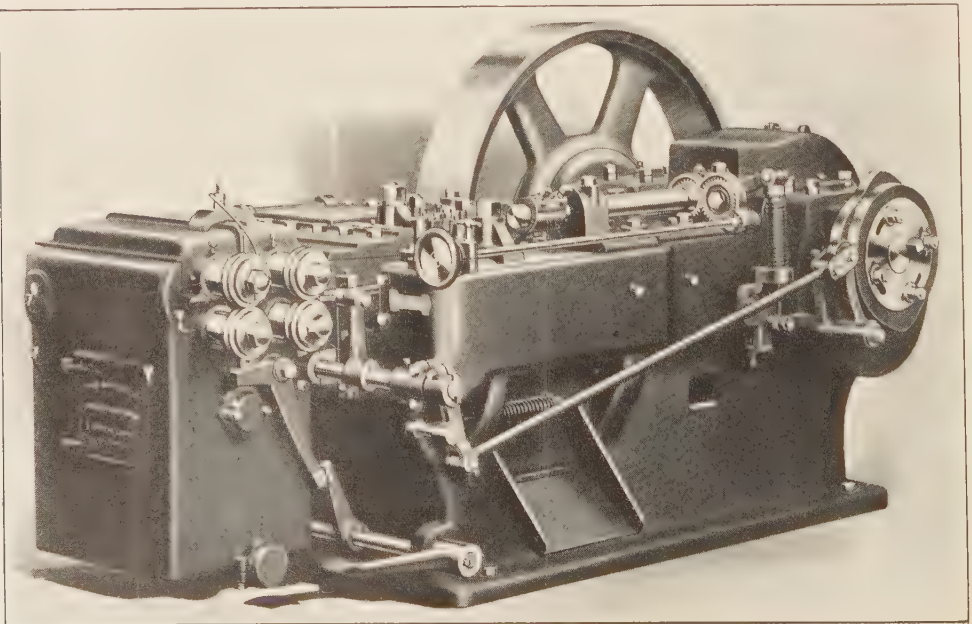
More than 600,000 were sold to the Union and Southern Pacific Railroads as a single order last year, and some 30,000,000 are in use throughout the world.

The device is made by the Richmond Screw Anchor Company of 9 Church Street, New York, who will furnish fuller details and samples on request.

NATIONAL AUTOMATIC FEED RIVET MACHINE

THE National Machinery Company, Tiffin, Ohio, are devoting considerable effort to the development of automatic and semi-automatic equipment of this type, with a view to eliminating the excessive manual labor required in the operation of such machines as

rivet machines, bolt headers, nut tappers and the like, as experience shows that the operator of such machines is subject to great body fatigue, which results in decreasing his efficiency or productive capacity, and consequent losses in output.



We illustrate herewith a new design of automatic feed for National wedge grip rivet headers which has recently been perfected by this company, and which embodies some novel features. In this machine long rods in mill lengths, taken on the initial heat from the finishing rolls or reheated in special long furnaces, are started into the feed rolls by the operator, the rod being advanced automatically and a blank sheared and headed, and a finished bolt or rivet ejected at each revolution of the machine.

Single-blow bolts, rivets, track bolts, or any type of "single-blow" work can be made in this machine, and the "wedge" gripping mechanism insures a product free from swollen shanks or objectionable fin along the body, as the dies cannot "spring" or give during the upsetting. The feed rolls are chilled castings and

are water-jacketed, thus maintaining an even temperature and insuring minimum wear on the feeding surface, hence positive and uniform "feeding." A new type of stock gauge is employed, which is designed not only to allow rapid and minute adjustment while the machine is in operation, but also to eliminate "spring," and thus secure high uniformity in the quality of the product.

In plants where these headers are operating, outputs are secured 50 to 100 per cent larger than obtainable on the hand-feed machine, and due to the accuracy and uniformity in feeding a better quality of output also is secured on the automatic feed header. The "Wedge" grip feed header with automatic feed is built in 1, 1 $\frac{1}{4}$ and 1 $\frac{1}{2}$ -inch sizes, illustrated and described in Circular No. 1016 issued by the National Machinery Company.

NEW METHOD OF MEASURING STEAM CONSUMPTION

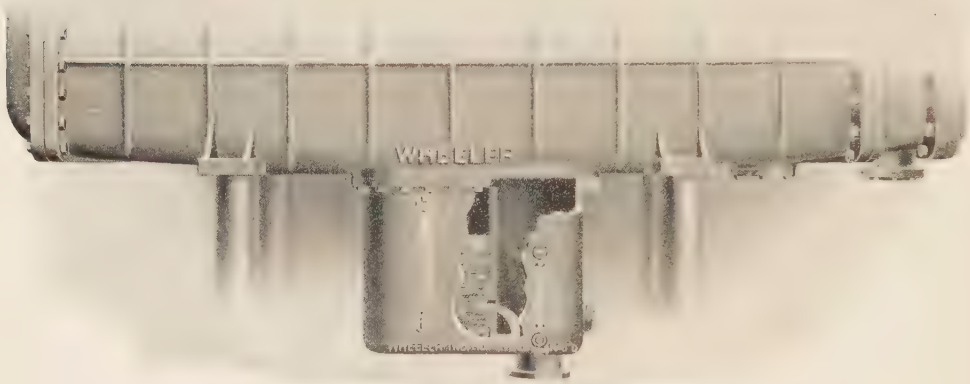
THE steam consumption of a turbo generator has been reduced to as low as 12 pounds per kw. hour. This high economy is secured by careful operation and by refinements in efficiency of auxiliary apparatus. But if the operating force has no guide in maintaining high efficiency, a fall in pressure, superheat or vacuum, a badly adjusted load, or wear of turbine blades, may cause loss of economy which is far more serious than is realized. For instance, in a recent case, a turbine had been operating for some unknown reason, at 125 per cent. of its normal steam consumption. This condition was not discovered for some time, in fact until the boiler load had become so excessive that it could no longer pass unnoticed. Finally, after several months it was concluded that the trouble lay with the turbine and

steps were taken for making proper repairs. In the meantime the excessive steam consumption of the turbine had caused a loss of about five tons of coal per 1,000 kw. per day, or in 3 months, with coal at \$3.00 per ton, a loss of \$1,350 per 1,000 kw. load.

The steam consumed by a turbine or engine can be determined with absolute accuracy by weighing the "steam water" or condensate from a surface condenser. Very few plants have employed this method of measurement, due to the fact that ordinary weighing or measuring devices are costly and clumsy and add not only to the expense, but complicate piping and, withal, are none too accurate. A simple, accurate and direct solution of the problem is presented in the Indicating Hot-Well, which is similar in size and appearance to the

ordinary hot well and is attached directly to the bottom of the condenser, forming a part of the shell. This adds another valuable function to the equipment, which has for its purpose besides maintaining high vacuum, that of providing pure distilled water for boiler feed, of heating this water to the highest feed temperature, the

gauge glass is also provided to show the height of the water in the hot-well suction compartment, where the water must not be allowed to submerge the orifice. The scale attached to the indicating gauge reads directly in pounds of steam per hour. Each orifice is made independently, carefully calibrated, and a special scale,



measurement of the amount of condensate, and the rate of steam consumption of the engine or turbine.

The Indicating Hot-Well is attached directly beneath the condenser, as shown in the accompanying view. The opening in the bottom of the condenser is built so that the condensate drains into the left-hand chamber of the hot-well, and communication from this chamber to the hot-well pump suction is secured through an orifice in the dividing wall.

The orifice is formed in a brass plate inserted in the partition wall. It is polished and finished to insure accuracy of flow. Especially manufactured fittings are used to attach the indicating gauge to the shell of the hot-well. Ball check valves are provided in each fitting so that should the gauge glass break the inflow of air will be prevented and the gauge glass can be replaced at leisure. A

etched upon steel, furnished for it. Over the whole range of readings the accuracy is within 2 per cent, and for readings from 75 per cent to 125 per cent load, the accuracy is within 1 per cent.

The Indicating Hot-Well is a practical and simple solution of the problem of measuring steam consumption. The indicating gauge reads pounds of steam per hour; the station watt meter gives load in kw., and the rate of steam consumption in pounds per kw. hour is obtained by simple division. This figure entered regularly upon the engineer's log sheet, and charted from day to day, is of the greatest importance in maintaining high plant economy.

This device is fully described in a bulletin of the Wheeler Condenser and Engineering Co., Carteret, N. J., who will send copies on request.

ORMSBY DIRECT ACTING SASH OPERATOR

THE accompanying view shows an installation of the Ormsby direct acting sash operator in the naphtha cleansing room of the Lewandos Dye Works, in Watertown, Mass. Thirty-five metal shutters in two lines are united together and operated from the outside of the opposite side of the building, taking but two seconds to close the shutters, thus stopping draft. The superintendent states that the device has paid for itself several times over when fires have started in this room.

The Ormsby sash opener is designed principally, however, for the operation of ventilating sash in factories or in greenhouses. The sash are opened by the direct action of the lifting rack on the sash, thus preventing any side motion, wobbling, or wrenching of the sash. The main shaft revolves, with gears provided to drive the lifting rack, thus producing

a direct power found in no other device. Any single sash or group of sash may be disconnected instantly in a very simple manner. A peculiarity of the device is that the sash are counterbalanced by properly adjusted springs, thus requiring a minimum



amount of power for the operating rod.

The manufacturer, E. A. Ormsby, 71 Summer Street, Melrose, Mass., will furnish full details respecting the device to those who may make application.

BOWSER NON-OVERFLOW FILLER FOR HAND OILERS

S. F. BOWSER & CO., Inc., Ft. Wayne, Ind., are placing on the market an outfit for use in factories, textile mills, oil houses, etc., where hand-oilers are used to any great extent. The outfit is designed for storing lubricating oil and is provided with a quick-acting pump which is used in filling the different sized hand-oilers. The pump is provided with an adjustable table or platform which operates with a lever. The hand-oiler is placed on this table and the lever is pushed down, which throws the oiler into the proper position, fitting the nozzle into the opening of the hand-oiler. The height of the table can be adjusted instantly and accommodated to differ-



ent heights of oilers. When the oiler is in the position to be filled the nozzle of the pump fits into the oil can, making a perfectly oil-tight connection. A few quick strokes of the pump fills the can. Any amount over the capacity of the oiler is discharged back into the storage tank by means of an overflow line provided for that

purpose, which positively prevents spilling the oil or mussing the can. The cabinet is provided with a metal hood which may be closed and locked, thus insuring clean oil.

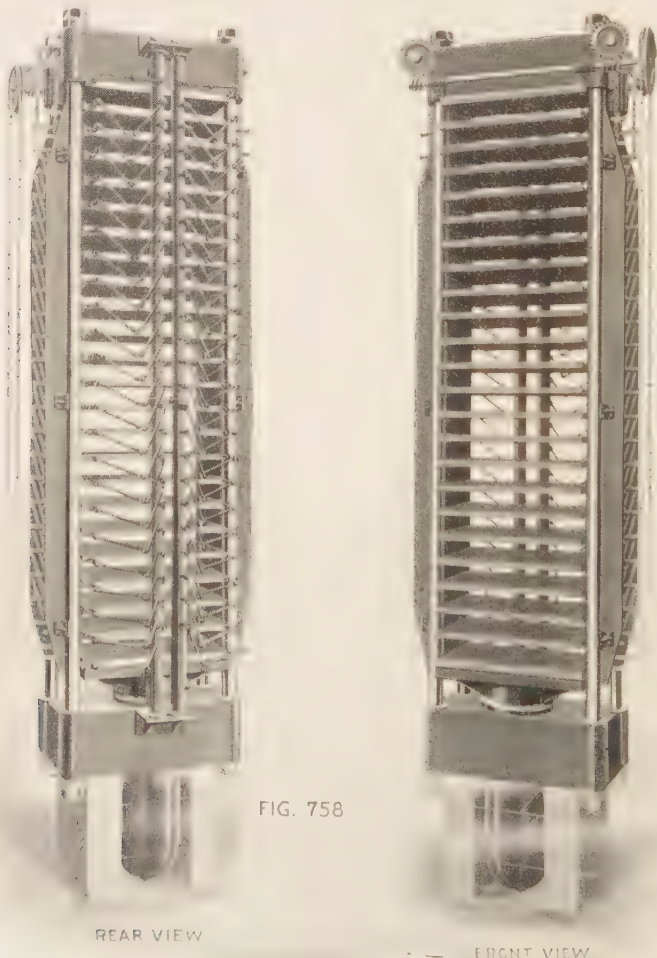
This equipment saves time and labor, and is especially convenient in textile mills and similar places where it is essential to keep the hands free

from oil. It eliminates the use of waste, which ordinarily is soaked full of oil and becomes a constant fire hazard. The outfit is guaranteed fire-proof, is made of sheet steel, finished in bronze green. Where it is especially desired, the finish may be changed to conform to the finish of the room in which it is to be used.

AN IMPROVED SILK PRESS

A NEW silk press has been designed and built by the Hydraulic Press Manufacturing Company of Mount Gilead, Ohio, to meet the special needs of silk finishers. The press as shown in the illus-

tration, which presents both a front and a rear view, is of the type known as hot plate press. The total height from the floor to the top of the press is nineteen feet. The press ram is twelve inches in diameter and has a



run of two feet. The hot plates, twenty-six in number, are forty-six inches long, thirty-two inches wide, and one and three-eighths inches thick. Each plate is heated by means of a seamless electric welded steam coil. This coil is so arranged as not to come in immediate contact with the plate, on account of which fact the plate is evenly heated by uniform radiation.

Steam enters the port seen at the upper end of one of the large vertical pipes, passes through the small pipes, which are equipped with flexible joints to provide for travel of the plates in the operation of the press, and after circulating through the coils within the plates, escapes by way of the port at the lower end of

the second large vertical pipe. The plates are spaced at intervals of six inches and have each a definite position of rest from which they can move upward according to the amount of compression of the material and to which they return upon release of the pressure on the ram. For convenience in placing the material between the plates, the upper one of any two plates can be raised to any convenient height by means of an arrangement of chain and gears operated by the long continuous chain seen hanging at the side of the machine. The press complete weighs 36,136 pounds and has a total pressure capacity of 250 tons.

AN AUTOMOBILE AUDITOR

THE speedometer "an automobile auditor." The popular impression is that a speedometer is used only for telling speed and distance traveled. For the practical autoist, the man who wants his car to give him all the service he has paid for, the speedometer, in conjunction with its odometer feature, has many other applications. First of all, it will pay its cost many times over in a year, for instance, by providing claims for rebates on tires which many manufacturers guarantee to cover a certain number of miles. In the event they do not last the mileage guaranteed, a pro rata allowance is made on the next purchase. It is only necessary to make a memorandum of the date the tire is put in use, and the mileage recorded by the odometer. Then when the time comes to replace the tire, the odometer will show if the tires have covered as many miles as the guarantee calls for. By the same simple process the odometer will save considerable money on gasoline, an item that amounts to no inconsiderable figure

every month. The filling of your tanks is generally left to others and you have no means of knowing if you get the full amount of fuel you are paying for unless you check it up now and then with your odometer.

The odometer will also audit the engine efficiency by permitting you to keep it tuned to a point at which you get maximum efficiency with a minimum fuel consumption. Test it now and then with an odometer, and make certain your engine consumes a quantity of gasoline proportionate to the number of miles the car has covered. The same instrument will audit the battery service and help to determine which make of battery gives longest service.

Another and more important thing: when the time comes to purchase a new car to replace the old, it is well to know if that make of car gives the service it should. The odometer will help to determine if you will be justified in purchasing another of the same kind.

"Joy riding" is nearly an impossibility with a car supplied with a

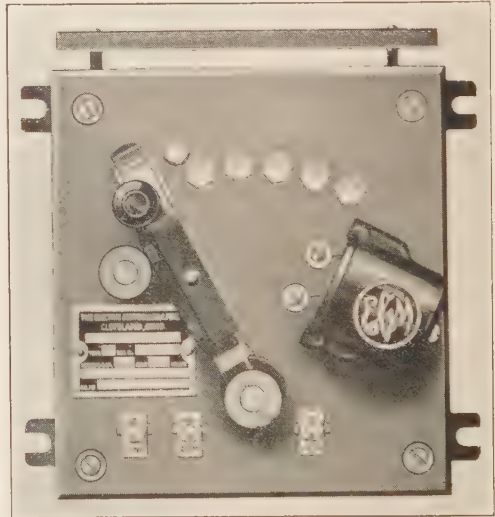
speedometer, as the first unauthorized use of the machine will show on the odometer.

Few realise to what extent speedometers are now used. Many car manufacturers supply them as standard equipment, as part of the car, which means that the speedometers must be manufactured in large quantities. Perhaps one of the largest, if not the largest, speedometer factory in the world, is located in Chicago, manu-

facturing the Stewart Speedometer, which requires a factory occupying four acres of floor space and necessitates over 500 employees, with an output of over 1,500 per day. In this branch of the industry as well as in other lines, service is an important feature. The Stewart Speedometer company has eleven branch offices across the country in all important cities from Boston to San Francisco, from which orders are promptly filled.

NEW MOTOR STARTING RHEOSTATS

THE Electric Controller & Mfg. Co., Cleveland, Ohio, has recently placed on the market a new line of starting rheostats for series, shunt, or compound wound, direct current motors. The manufacturers claim the following important advantages for these rheostats: The highest grade of Monson slate is used, having beveled edges and oil finish. On all sizes the contacts are removable from the front of the rheostat, without disassembling or interfering in any way with the wiring or resistance. The retaining magnet is iron-clad, thus being protected from mechanical injury. The resistance wire, the capacity of which is liberally proportioned, is wound on asbestos covered, metallic tubes through which a draft of air flows. While this draft of air very efficiently conveys the heat away from the resistance, yet it does not at any time touch the hot resistance wire, the ob-



vious result being unusual freedom from oxidization of the resistance wire.

The E. C. & M. motor starting rheostats are regularly furnished in sizes from $\frac{1}{4}$ h.p. to 35 h.p., 110 volts and from $\frac{1}{4}$ h.p. to 50 h.p., 220 and 550 volts.

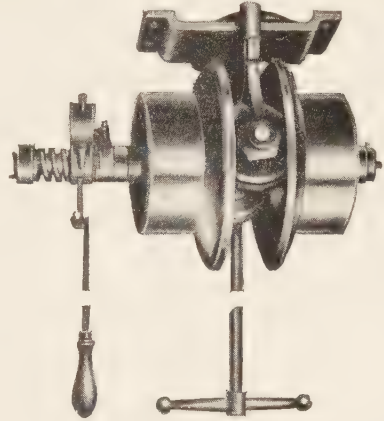
SPEED CONTROL DEVICE

THERE has been brought out by the Cummings Ship Instrument Works of Boston, a rather ingenious device for varying the speed of pulleys driven by a constant speed belt. One type is a single

speed controller used for light work. Either pulley may be connected by a belt to line shaft of shop, which of course will run at a constant speed, and the speed of the pulley, which runs in opposite direction, is made to

vary by means of handle shown suspended between the two pulleys. The speed is controlled by the angle of contact of the rollers to flange of pulleys, which is a curved surface with center of roller as its center. By manipulation of the handle the angle of these rollers may be changed through two arcs of gear wheels meshed with each other and which control the spindles on which the rollers revolve. By this arrangement the rollers are always kept in an equal and opposite angle to the flange of the pulleys, and when one side moves towards the larger diameter of one flange the other side moves toward the smaller diameter of other. The rollers consist of discs of compressed paper held together by two cast iron flanges and can be easily renewed, but experience has shown that under ordinary loads they will last five or six years before requiring renewal. The handle shown at the left controls the spring that holds the pulleys together, and when in one position the pressure of the spring is released from the pulleys, which causes one to run idle on the shaft.

The cut shows a duplex controller used where heavier work is required. By using four rollers instead of two the capacity of the machine is doubled. The speed ratios in these machines are from 1 to 7 and they possess the advantage of attaining any desired speed within this range



without stopping, and instead of steps as on a cone pulley, the speed changes constantly. Some manufacturers, such as paper rolling machinery, have found it useful to connect the speed changing handle to the roller so that the speed changes automatically as the roll becomes larger.

CIRCULATION TEST OF ROBB-BRADY SCOTCH BOILER

THE Robb-Brady Scotch boiler is a modified form of the Scotch marine boiler, the changes from the standard form increasing the circulation. The heating surfaces are arranged as in the standard form and there are the same internal furnace flues, but there are two smaller shells, one above the other, in place of the large one, and an annular circulating passage is formed at the front end by the use of a plate beneath the front neck. This plate guides the cooler feed water around the shell, discharging it be-

neath the furnaces at the front. The water is heated while passing around the furnaces and among the tubes, and enters the steam drum by the rear neck.

The claims for positive circulation made by the builders were thoroughly tested a short time ago at the Sewerage Pumping Station, Framingham, Mass. The Robb-Brady boiler at this plant was equipped with thermometer oil wells so that the temperature could be noted at four points: At the top of the shell near the front end, at the top of the shell at the rear just

Time P. M.	Thermometer No. 1 Top of boiler at rear.	Thermometer No. 2 Top of boiler at front.	Thermometer No. 3 Bottom of boiler at front.	Thermometer No. 4 Bottom of boiler at rear.
3:40	114° F.	112° F.	80° F.	82° F.
3:45	126	124	80	82
3:50	138	140	80	83
3:55	150	150	81	84
4:00	170	170	82	86
4:05	194	190	84	87
4:10	210	210	98	90
4:15	226	224	210	136
4:20	231	230	226	180
4:25	244	242	234	230
4:30	258	260	252	248
4:35	276	278	268	270
4:40	292	292	292	290
4:45	310	308	306	310
4:50*	328	330	328	328
4:55	330	330	328	330
5:00	327	328	327	327

*Safety valve blowing off.

TEMPERATURE TEST OF 50 H. P. ROBB-BRADY SCOTCH BOILER

over the combustion chamber, at the front and rear, close to the bottom.

With water in the boiler at about 80 degrees the fires were started and readings of all thermometers taken every five minutes. As was expected, the temperature of the water at the top of the shell increased steadily until the boiling was reached. At the bottom, the temperatures increased very slowly up to the time the upper thermometer indicated the boiling point. Then the lower thermometers showed sudden rise; they jumped to within a few degrees of those at the top. From this time on all four kept within a few degrees until 100 pounds was reached, at which time practically no difference could be noted at the four points, showing conclusively that the circulation was positive and rapid. How well this design fills the purpose is shown in the accompanying table which gives graphically the thermometer readings at five minute intervals. The test proved that trou-

bles due to poor circulation in marine boilers are a thing of the past; that positive circulation is easily obtained with the Robb-Brady device which forms an integral part of the boiler, not an external apparatus. The boiler is built under patents held by the Robb Engineering Company, Ltd., of South Framingham, Mass., and Amherst, N. S., Canada.

The test was witnessed by many prominent consulting and operating engineers. A large delegation came from N.A.S.E. lodges Nos. 1, 12, 14, and 30 from Boston and Cambridge. Representatives of several boiler insurance companies were present, among whom were: T. G. Ranton, chief inspector of the Fidelity and Casualty Co., Boston; C. E. Goodwin, chief inspector of the Royal Indemnity Co., Boston; chief inspector Melcher of the U. S. Guarantee and Casualty Co., Boston, and representatives of the Employers' Liability Co.

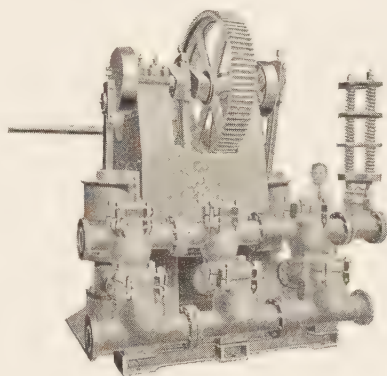
GOULDS SELF-ACTING TRIPLEX PLUNGER-PUMP

THE Goulds Manufacturing Company, Seneca Falls, N. Y., have just placed a new high-pressure triplex power pump on the market. This pump, known as Fig. 1585, is similar to their Fig. 1283 type, which is in general use in mines, water works, and with hydraulic presses, oil pipe lines, etc. The chief difference is in the gearing. As shown by the illustration, the new pump has only one gear and pinion, which are located between the standards. Figure 1283 had two sets, one on each side of the standards.

The placing of the gearing between the standards necessarily lengthened one side of the pump somewhat, and increased the distance between the two valve boxes on that side. Instead of lengthening the pipe connection between the valve boxes on one set and making each set of a different shape, as they are in many pumps, a dis-

tance piece is put in as shown. In this way the three sets of valve boxes are kept identical in form and interchangeable.

This duplication of parts is a fea-



ture of Goulds pumps and saves time when repairs are needed. It also reduces the number of parts kept in stock by the large user who may be at a great distance from the factory.

OUTDOOR TYPE OIL CIRCUIT-BREAKERS

COMPANIES distributing electric energy over long transmission lines are often anxious to take on business along these routes, but the volume is usually so small that the consequent revenue does not begin to justify the erection of a sub-station with its attendant expense. The advent, however, of outdoor type apparatus into the field has gone a great way towards solving the problem.

By its use, the distributing company may often acquire attractive business in small quantities at a reasonable outlay. The most important piece of apparatus to be considered in such an installation is the oil-switch

or circuit-breaker for the control of the feeder circuits.

Another very advantageous use of outdoor type oil circuit-breakers is for sectionalizing feeders and transferring the load from one line to another without interrupting the service. Thus it will readily be seen that a distribution company, by use of the outdoor type breakers, is able to improve its service at a low cost, as well as build up the load at a small expenditure. Circuit-breakers for successful use in such service must possess certain essential characteristics that render them adaptable to use outdoors. A circuit-breaker, to meet successfully the demands made upon

it in such service, must be simple but sturdy in construction. Appreciating the demand for a simple but absolutely reliable outdoor type oil circuit-breaker for moderate capacities and voltages, the Westinghouse Electric & Manufacturing Company has placed on the market a modification of the type B breaker which has been successfully used as an indoor type for some years past.

This breaker has a separate tank for each pole, the tanks being made of welded seam boiler iron with an insulating lining, thus permitting an easy inspection of the contacts.

The breaker may be either automatic or non-automatic in the tripping operation. The automatic tripping is effected by the use of current transformers located as an integral part of the circuit-breaker, one transformer for a two-pole breaker, three for a three-pole breaker, and two for a four-pole breaker. This arrangement affords absolute protection under all conditions and the use of less than three transformers for a three-pole breaker is not advised.

The breaker is full automatic in its action, that is, cannot be held in closed position while a continued overload or short circuit exists on the line.

The outdoor hand operated type breaker is entirely self-contained mounted on a substantial cast iron frame that can be set in any location and requires no foundation, bed plate, or base. This feature renders the installation of the breaker a very simple and inexpensive matter.

The fact that each pole is enclosed in a separate tank renders the inspection of the contact mechanism a very easy matter. The overload current transformers are mounted within the enclosing case of the breaker, thus being thoroughly protected from the weather and accidental contact

with the operator. The leads from these transformers pass directly to the trip coils of the breaker which are also enclosed in the housing.

Insulated leads are brought out through heavy corrugated porcelain bushings and are left of a sufficient length to enable connections of any kind convenient to the installation to be made.

Sight gauges are supplied on each oil tank for determining the height of the oil, and the tank is filled with the oil through a plug located just above the sight gauge, so that both of these operations may be performed without removing the tank.

In the end of the housing is a hinged cast iron door fastened by means of a bolt and winged nut which permits ready access to the calibration mechanism.

These breakers are calibrated before leaving the works for service on which they are to be used.

Leads for indicating lamps that show the position of the contacts are brought out on the under side of the case and may be carried to any convenient location for the lamps.

The breakers primarily intended for hand operation can be furnished for electrical operation as well when so desired. A wooden closing bar is furnished for closing the breaker. This bar is inserted in the socket connected to the contact mechanism when it is desired to close the breaker, and then removed, the handle-socket serving as an indicator of the position of the contacts.

A vent pipe with a double opening is attached to the top of the weather-proof housing to permit the escape of gases arising at the time of the operation of the breaker under load.

The housing is so constructed that it can easily be removed, permitting a ready inspection of all parts of the

breaker, at the same time, when assembled it forms an entirely waterproof compartment.

All live metallic parts inside the case are well insulated and any danger of flashing from them to the case is eliminated.

The type B breaker, due to its rugged construction and ample proportions, is well adapted to the control of circuits of moderate capacity and voltage in outdoor installations. In the number of installations where

it has been used it has successfully met the most severe conditions to which it has been subjected. It is believed that the introduction of this outdoor apparatus marks the beginning of an important development in the sale of electrical energy, as it furnishes a means of supplying many small communities, and even individual consumers from transmission lines where the amount of revenue to be derived absolutely precludes the idea of a sub-station with its attendant expense.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Air Compressors

NATIONAL BRAKE AND ELECTRIC CO., Milwaukee, Wis.—Publication No. 391, showing motor and belt driven air compressors. The machines are described in great detail and many tables of considerable interest are added.

Automatic Engine

STERLING MACHINE CO., Norwich, Conn.—Bulletin No. 103 illustrating the Acme automatic steam engine for driving blowers, pumps, generators, stokers, rock drills, etc.

Boiler Cleaner

BAYER STEAM SOOT BLOWER CO., 2828 La Salle Street, St. Louis, Mo.—Pamphlet showing the Bayer soot blower system for watertube boilers. This system has been adopted by the Heine Safety Boiler Co., and is now a part of their regular boiler equipment.

Concrete Construction

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS, Philadelphia, Penn.—An extensive book treating of the subject of factories and warehouses of concrete.

Electric Tools

JAMES CLARK, JR., ELECTRIC CO., Louisville, Kentucky.—A handsome catalogue showing the "Willey" line of electrically driven portable tools, together with "Willey" dynamos and motors.

Gas Engines

INTERNATIONAL GAS ENGINE CO., Cudahy, Wis.—Handsomely printed catalogue of the "Ingeco" line of gas, gasoline, oil and producer engines, ranging in size from the

smallest type of farm engine to high powered engines for large power plants.

Grate

CYCLONE GRATE-BAR CO., Buffalo, N. Y.—Pamphlet describing the cyclone shaking and dumping grate constructed on the clip and truss plan,—having two trusses lengthwise, and the clips are bridged across these trusses, each clip forming a double brace with the trusses.

Grinding Wheels

NORTON CO., Worcester, Mass.—An elaborate catalogue showing an extensive line of grinding wheels and machinery.

Heating and Ventilating

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y.—Well printed booklet on heating and ventilating, with information and tables for the design of heating and ventilating systems.

Oil and Water Separators

DIRECT SEPARATOR CO., 218 South Geddes Street, Syracuse, N. Y.—Pamphlet describing Sweet's combination oil and water separators for low pressure.

Oil Engines

BUSCH-SULZER BROS.-DIESEL ENGINE CO., South Side Bank Building, St. Louis, Mo.—Bulletin No. 102 relating to the Diesel oil engines as applied to ice-plant and brewery requirements.

Oil Filters

FRANKLIN OIL FILTER CO., St. Louis, Mo.—A neat pamphlet describing the line of Franklin oil filters, oil tanks, oil cabinets, fittings and accessories.

Piping Materials

BEST MFG. CO., Pittsburg, Pa.—Catalogue No. 103, an elaborate hand-book of piping materials for steam, air and hydraulic uses.

Power Chains

DIAMOND CHAIN AND MFG. CO., 250 West Georgia Street, Indianapolis, Ind.—A treatise on power chains and sprockets, followed by a catalogue of Diamond chains.

Rail Planer

VIXEN TOOL CO., 5,001 Lancaster Avenue, Philadelphia, Pa.—Bulletin A, describing the Vixen rail planer, consisting of a portable cast iron and steel holder to which is attached a Vixen file, especially made and treated to meet the requirements of planing down raised and cupped joints and rail corrugations of every description.

Reamers and Taps

LAPOINTE MACHINE TOOL CO., Hudson, Mass.—A brief catalogue presenting a full line of standard reamers and taps.

Reinforced Concrete Construction

C. A. P. TURNER, Suite 816, Phoenix Bldg., Minneapolis, Minn.—Bulletin No. 12, showing examples of the "Mushroom" system of reinforced concrete construction.

Rib Lath

TRUSSED CONCRETE STEEL CO., Detroit, Mich.—Pamphlet showing rib lath for stucco and plaster in sidings, partitions, ceilings and furring.

Rock Drills

CHICAGO PNEUMATIC TOOL CO., 1,010 Fisher Bldg., Chicago, Ill.—Extensive catalogue, No. 36, showing a complete line of air compressors, pneumatic and electric tools and appliances.

Screw Machine

DAVENPORT MACHINE TOOL CO., New Bedford, Mass.—Bulletin describing the Davenport multiple spindle automatic screw machine.

Shop Heating

AMERICAN BLOWER CO., Detroit, Mich.

—A treatise on shop heating, containing many practical suggestions.

Sifting Machine

HANNA ENGINEERING WORKS, Chicago, Ill.—Catalogue No. 1, showing a complete line of Hanna sifting machines.

Steam Specialties

JOHN SIMMONS CO., 106 Centre Street, New York.—A complete catalogue and price list of wrought and cast iron pipe, brass and iron valves and fittings, together with plumbing supplies.

Steam Turbines

ALBERGER PUMP CO., 140 Cedar Street, New York.—Catalogue D, describing centrifugal pumps, volute pumps, condenser pumps, fire pumps, boiler feed pumps, and Alberger steam turbines adapted for driving centrifugal pumps.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass.—Bulletin No. 59, relating to recording liquid level gauges.

TERRY STEAM TURBINE CO., Hartford, Conn.—Bulletin No. 12, showing several tables of tests of Terry steam turbine gas blower sets.

Time Recorder

STROMBERG ELECTRIC CO., Chicago, Ill.—Booklet illustrating the Stromberg electric chronograph and electrically operated time recorder, controlled by a master clock and adapted for any field where a time recorder is wanted.

Water Softener

WM. GRAVER TANK WORKS, East Chicago, Ind.—Bulletin describing the operation and construction of the Bartlett-Graver water softener and purifying system.

Welding

TOLEDO ELECTRIC WELDER CO., Knowlton and Langland Streets, Northside, Cincinnati, O.—Bulletin No. 11, referring particularly to butt welding, accompanied by many illustrations of Toledo electric welding machines.





